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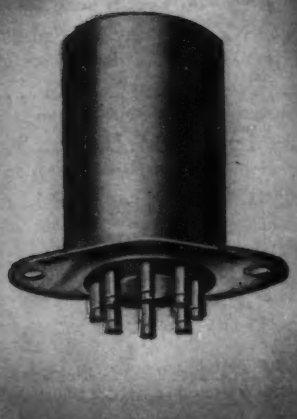

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Disposal of Government War Plants and Equipment

In the last four years, the Federal Government has pent over fifteen billion dollars on war plants – two-nd-one-half times as much as was spent by private nvestors.

Of this fifteen-billion-dollar government investment, bout one-third has gone into facilities for the manu-acture of aircraft and for ship construction and repair; nother third has gone into plants for production of ombat ordnance; and the remaining third has gone into variety of facilities for making synthetic rubber, metal roducts, machinery, and miscellaneous equipment.

Most of these plants are in industries that are ex-anded far beyond peacetime requirements. Further-nore, their convertibility to other civilian uses will, in nany cases, be complicated by their specialized equip-nent and layout, by their tremendous size, and by their neconomic location. At the moment, it looks as if oughly one-third of the government-owned plants and quipment can be converted fairly readily to peacetime peration, and will, therefore, be easily disposable to rivate enterprise.

The discovery of unsuspected uses for war plants and quipment may well raise the disposable proportion to ne-half or more. The government, at the end of the ar, may own about one-eighth of the commercially-sable industrial capacity of the country. It will be by r the largest owner of machine tools; it will own enor-ous aluminum capacity, magnesium capacity, many iles of pipe lines, and more ships than the entire rivate shipping industry.

What the government does with its war plants will ave a profound effect on the free enterprise system and n all workers, employers, investors, and consumers who ave a part in that system. If this problem is handled adly, we may find ourselves enmeshed in a trend to-ard monopoly and government operation of industry. f the problem is handled well, we shall have taken a ig step toward freedom of action in a competitive ociety, toward full opportunities for business enter-rise, toward well-paid productive jobs for workers, and oward a higher standard of living for us all.

Recently, three important events have signalled en-ouragement. They are the report of Senator George's Committee, the Baruch report, and the report of Sena-or Truman's Committee. These reports are noteworthy or their competent sizing up of a complex problem, or their recognition of the major responsibility of gov-rnment in making a successful transition to peace, for heir insistence on wise policy and good administra-ion, and for their genuine concern that our productive owers be given full opportunity in a free private enter-rise system. These reports agree on basic principles nd many specific lines of action. There are, however, important areas of policy formation, organization, and procedure—especially in regard to plant disposal—which remain to be blue-printed.

In formulating the policies and practices to be followed in dealing with government war plants, our major goal must, of course, be a high level of production and employment in private business after the war.

Government operation in competition with private employers and privately-employed workers will not be desirable because it will make investment unattractive to private capital and will limit opportunities for private employment. On the other hand, sales to private buyers which result in increasing the concentration of industry will also be undesirable. We must use this opportunity to strengthen the competitive enterprise system and to move away from, not toward, the concentration of economic power in either public or private agencies.

To accomplish these objectives, a program of action such as follows will be necessary:

1. An adequate reconversion organization will be needed in the government, but its powers and responsibilities should carefully be defined by Congress. Fortunately, an able Administrator of Surplus War Property already has been appointed. It will be essential for him to work in closest cooperation with Congress and with the Armed Forces and other executive agencies. The Office of War Mobilization, and ultimately the President, must be responsible for seeing that the Surplus War Property Administration is not sidetracked by the operating agencies and is not dominated by their sheer size. Funds must be supplied generously to the Surplus War Property Administrator, so that he can set up an organization adequate to cope with this huge and complex job. Business, too, must be generous in loaning top-flight executives for postwar government service.

2. One of the first acts of the Surplus War Property Administration will have to be to assemble a complete inventory of government war plants and equipment, to make possible the planning and control of the disposal process, and to form the basis of catalogues of property available for sale.

3. Cooperation between the executive and legislative branches of the government will be needed to develop at least tentative plans with respect to matters of public policy which are of special importance to a successful transition to peace. Among these matters are the size of the military establishment to be maintained in time of peace, the stand-by facilities and reserves of materiél necessary for our security in case of future war, and our policy regarding import and production of synthetic rubber and other critical and strategic materials.

4. The Surplus War Property Administrator should

obtain from the Armed Forces, acting under congressional directives, specification of those plants which are needed to supply our peacetime Army and Navy and to provide the essential reserve capacity in case of war.

5. The Surplus War Property Administrator should select certain war plants as depots in which to store the huge surpluses of inventories and equipment which will have to be removed from private and government-owned factories in order to make possible their conversion to civilian use.

6. Those plants which are not desired by the Army or the Navy, which are not needed for storage, and which clearly will be unsuitable for peacetime utilization should be scheduled for dismantling and disposal piecemeal.

7. The two or three billion dollars' worth of government facilities intermingled with private plant should receive attention with a view to early sale, temporary continuance or use under lease, or early removal.

8. The various plants and pieces of equipment available for sale to private business should be classified conveniently, catalogued, and advertised to prospective buyers or lessors. Before the Surplus War Property Administrator offers, for private sale, plants and equipment not desired by the Army or the Navy, he should ascertain whether the plants or equipment are desired by other branches of the government or by public corporations such as the T.V.A.

9. Whenever property can be sold at prices approximating depreciated reproduction cost, that will be by far the best solution. Generous time-payment terms should be offered. In many cases the government may be unable to sell the property for reproduction cost less depreciation, for the simple reason that no one would think of reproducing it. The property may already be partly obsolete or, because of its size, location, or other characteristics, may only be moderately well suited for commercial use. This should not prevent the government from selling it, provided a price which fairly represents the worth of the property can be obtained. The best test of that worth is the price produced by active bidding under favorable market conditions.

10. When property cannot be sold at a fair price, temporary leases with options to buy should be employed to get the facilities into productive use. This should not, however, be done on terms which would cause unfair competition or create clearly excessive capacity in an industry. And the lease must be temporary; it must not be the means to prolong government control or ownership.

11. The government should offer the strongest possible resistance to local groups or industry groups seeking subsidies for continued operation of war properties. Subsidies will burden the Treasury and lead to inefficient use of resources. They will be justified only to maintain facilities needed for national security.

12. The plants and equipment offered for sale and lease should include sufficient quantities in small enough lots to satisfy the demands from small business. The war has tended to concentrate production in larger plants. After the war, we should seek a wider distribution of the government war facilities.

13. Insofar as possible, war buildings and equipment should be offered for sale in units which can be purchased by businesses in peacetime industries. Many of these industries have had to get along during the war without adequate replacement and expansion, and will be ready to buy if they are able to get what they want from the government. This is a particularly desirable market for surplus government property since these industries are, for the most part, not faced with the problems of excess capacity.

14. Property, such as machinery and other movable equipment, which is in excess of our domestic requirements or is more urgently needed by other countries should be exported. We shall need, and can take, large supplies of raw materials in return.

15. Property which is not needed by the Armed Forces, which cannot be sold or leased on terms which would be fair to competing plants, which cannot be dismantled and distributed piecemeal, and which cannot be sold abroad, should be scrapped as soon as its non-disposability is apparent. The disposal of war plants should be completed within three to five years.

16. All negotiations for sale or disposal should be matters of open public record. As Mr. Baruch has said, the process must be conducted in a goldfish bowl. This is as much for the protection of business as for the protection of the government.

These courses of action do not include everything that must be done, but they do indicate the general lines along which our surplus war plant disposal must proceed if it is to avoid precipitating needless transitional unemployment.

The gravest danger of all will be red tape, intergovernmental conflict, and inadequate administration. It would be a great misfortune for the executive and legislative branches to quarrel over details of organization when they agree on the basic principles to be followed in handling the problem. Obviously, the Surplus War Property Administration must cooperate with Congress and look to it for policy guidance. Just as obviously, the disposal problem will involve great difficulties of administration which must not be complicated by congressional interference. We shall need the best we can get in careful policy making, detailed planning, good organization, and courageous action. This is a matter of vital importance to every American. The stakes are too high to tolerate poor administration or petty politics.

James H. McGraw, Jr.

President, McGraw-Hill Publishing Company, Inc.

CROSS TALK

▶**SYMBOLS . . .** As outlined on this page in the March issue, a compromise set of components symbols was devised at a meeting held in New York on January 22 under the auspices of the American Standards Association. Letter ballots were sent to those who had an interest in the matter with the request that returns be made by February 15. By March 1 the ballots had been returned with a favorable vote by all except a few power people, who again raised objections.

As a result of this disagreement, the whole matter is still up in the air. Another meeting has been scheduled to iron out the troubles.

In the meantime, thousands of men are being trained exclusively in the communications symbols, several industrial electronic books using power symbols have been published and are practically unintelligible to anyone approaching industrial electronics from a communications background, authors request publications like ELECTRONICS to refrain from modifying symbols used in original diagrams to conform with the publication's style, and confusion reigns.

▶**TELEVISION . . .** There is a great deal of post-war talk about sight-broadcasting these days. There is little likelihood that the industry will wait for the inevitable, ultimate Utopian system to be developed before going on the air. Television will start off very much as it left off, with some changes in standards, some improvement. At the same time experimental work will not stop. Frequency channels will be made available for this forward-looking work. The prospect that some inventions or discoveries will be made and which will improve the present system vastly, perhaps make the present system obsolete, is a chance everybody will simply have to take.

First, however, the conflict between the desires of the FM enthusiasts and the television people for the same space in the spectrum must be resolved. Both services, justifiably, want more space.

Telephone company, in response to request from Niles Trammel, NBC president, indicates large-scale construction of coaxial cable in years 1945–1947 and requests television people to state their requirements so that proper plans for future tie-up system may be evolved.

Anticipating post-war television boom, Local 306, Motion Picture Operators' Union, is sending members to school to learn radio and television. They talk about shooting the television programs on wire lines (telephone) from a central station to a group of theaters so that all can show the same picture but pay for only one rental of the film. MPO wants its members ready for jobs at the local theaters. Telephone linesmen's union and radio broadcast operators' union are keeping their eyes on this business. Quite possible that they will whack it up amongst them, radio men at the transmitters, MPO's at the theaters, telephone men sitting on the wires.

▶**FM . . .** Decision of broadcast networks to make available to affiliated stations having FM outlets full network programs free of charge is a great decision for those with FM receivers. In New York, for example, full NBC and CBS programs are now available during the hours that the FM outlets are on the air. This puts the New York Philharmonic Society's Sunday afternoon concerts on CBS's FM transmitter.

General opinion now tends toward the idea that FM will grow and grow, that ultimately all of the locals and many of the regional stations will be on FM, thus relieving the congestion in the present AM band. The result will be the freeing of channels for high-power, wide-band, clear-channel transmitters serving communities not near enough to FM transmitters to get good reception.

Thus, as often happens, the advent of something new will not replace something old as was feared, but will actually make it possible to improve the older broadcasting system and enable it to perform a better service.

Idealists who hoped, somehow, that FM would improve soap box operas, cosmetic drivel, sales talk for "keep-regular" pills and other cheap whoopla are doomed to disappointment. This stuff sounds just as nauseating one way as it does the other. FM is no cure for mediocrity and bad taste.

RADIO FOR R

War-accelerated technical progress, the need for maximum transportation system efficiency, the improving financial position of railways, and the recent satisfactory experiences of ordnance plants with electronic equipment have fortuitously combined to stimulate growth of the field

By

WILLIAM S. HALSTEAD

President
Halstead Traffic Communications Corporation
New York, N. Y.

ON DECEMBER 23, 1943, the Association of American Railroads announced that it had requested the Radio Technical Planning Board to examine the public safety possibilities lying in the proposed use of radio-telephony by rail carriers. It is reported that this action was taken, in part, as a result of public comment that radio equipment might have prevented a series of major rail accidents in which heavy loss of life and property was involved.

As it has long been recognized that radio communicating systems have contributed to the safety and efficiency of air and water transportation, it may well be asked why the railroads have moved so slowly in applying radio signaling techniques to their communications problems.

Locomotive radiotelephone installation employed in the Proviso yard of the Chicago and North Western Railway

Reasons for Pre-War Hesitancy

There have been many reasons for hesitancy, including:

(1) The attitude of the railroad industry itself toward radio as a communicating medium. Although some railroads have conducted tests of radiotelephone equipment over a period of many years, and a few far-sighted railroad executives have studied the potential uses of radio apparatus, the industry as a whole has shown only occasional interest in the subject. This attitude has

POTENTIAL RAILWAY RADIO SERVICES

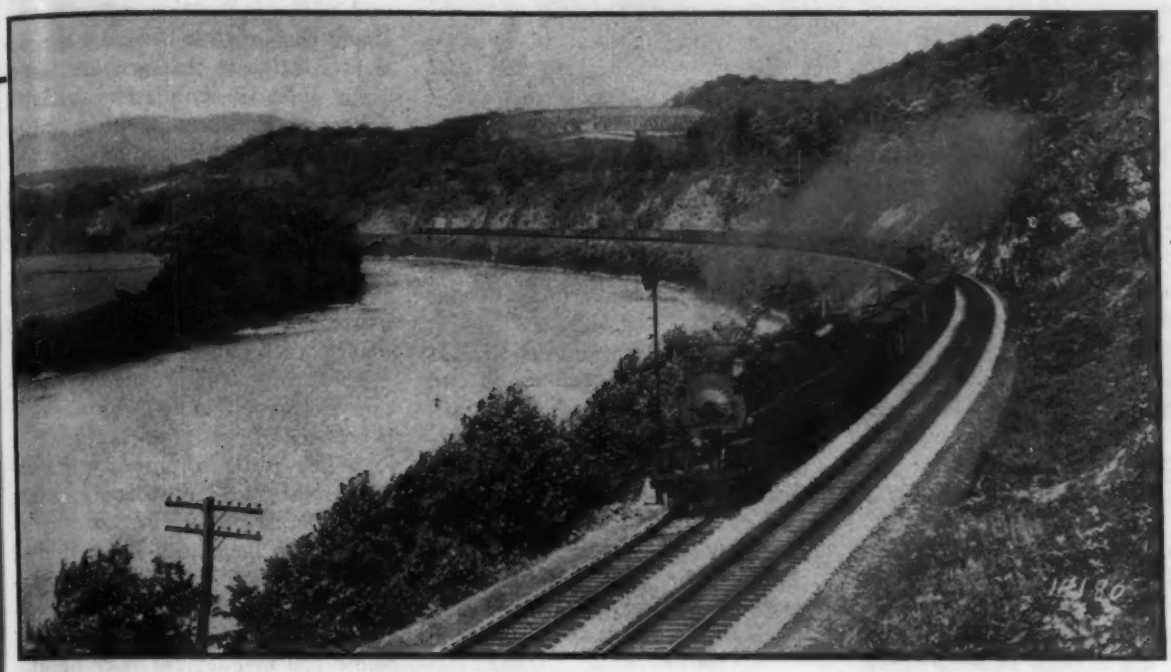
ON MAIN-LINE TRACKAGE

1. Locomotive cab to caboose
2. Train-to-train
3. Train-to-tower
4. Emergency communications
5. Control of cab signals
6. Passenger communications

IN YARD AND TERMINAL AREAS

1. Yardmaster to locomotive engineers or conductors
2. Towermen to engineers or conductors
3. Conductors (on trains or on ground) to locomotive engineers
4. Communications between locomotive engineers
5. Yardmaster to supervisory personnel on foot or in mobile units
6. Communication between ground personnel

RAILROADS



been enforced, to a large extent, by the financial burdens under which the railroads were obliged to operate. Also, the majority of railway executives have been trained in the older telegraph and telephone techniques, and therefore cannot be expected to appreciate the full extent to which modern radio equipment is able to provide many important services of value to rail operators, as well as to the traveling public.

(2) The lack of concerted effort on the part of radio manufacturing groups to develop and market radio communicating systems specifically engineered to meet the special requirements of railway operation. Efforts in this direction have been of a sporadic nature, in most instances, without the existence of a broad plan under which the railroad industry as a whole would derive maximum benefit from the use of radio equipment.

(3) The fear of the railroad brotherhoods that the adoption of radio communicating methods would result in a reduction in the number of men required to perform routine operations, thereby producing unemployment.

(4) Difficulties involved in Federal licensing, particularly with respect to allocation of suitable radio frequencies for railway communications. This problem is complicated by the fact that trains normally operate over long distances, thereby precluding the assignment of frequencies on the basis of limited-area coverage, as is the case in the majority of public utility services.

(5) Technical difficulties peculiar to railway installations of radio equipment, such as the existence of high electrical noise levels in the vicinity of electromotive equipment, wide variation in signal strength along trackage in industrial and mountainous areas, the need for continuous indication in mobile units that radio equipment employed for traffic control purposes is in operable condition, and the need for particularly efficient shock-mounting and housing of transmitters and receivers.

Emergency Gives Idea Impetus

In meeting the unprecedented demands of the war emergency, in which serious shortages of manpower and rolling stock have developed, the over-burdened rail carriers have given consideration to new methods by which the efficiency of existing equipment may be increased. This search for new and improved methods of operation has broadened, to a considerable extent, the viewpoint of railroad executives towards all technological developments. Simultaneously, increased income has put the railroads, for the first time in a number of years, in a financial position where they can give serious consideration to improvements of a basic nature. Finally, recent rail disasters, which emphasized the need for improved communicating methods in emergencies to supplement existing block-signaling equipment and wire facilities, have focused the attention of the more progressive railroad executives on the proposed use of radiotelephony to increase safety and efficiency of rail operations.

In analyzing the reasons for lack of substantial progress in the development and marketing of radio equipment adapted for use on railways, it should be pointed out that prior to the war period neither the railroad industry nor governmental agencies had much practical experience data with which to appraise the value of radio techniques in railroad operations. Most manufacturers, furthermore, were not pre-

pared to underwrite the costly research and development programs required in establishing the practical value of radio in the eyes of hard-headed and tradition-minded rail executives. However, one engineering group had initiated in 1937 a long-range development program directed toward the application of radio traffic-control and communications techniques on highway and railway transportation systems. This development program, utilizing deaigns of the original engineering group, was extended into the railway classification yard field in 1940 by one of the signal equipment companies, and during that year an experimental radio telephone communications system, engineered for railway use, was installed in the Proviso yard of the Chicago and North Western Railway.

The successful operation of equipment at Proviso, which incorporated automatic means for continuously checking on the operable condition of the system in accordance with railway signaling practice, was brought to the attention of the operators of the Kingsbury Ordnance Plant. The particular problem of this and similar plants was to obtain, on some 200 miles of trackage, maximum safety and speed in handling the rail movement of high explosives. As a result of tests conducted at Kingsbury, this and other government-owned ordnance plants have now adopted radio traffic-control methods. Thus the demands of efficient war production provided the opportunity to demonstrate the practical operating advantages of railway radiotelephony, while the use of radio equipment in ordnance plants over a period of two years has proved the degree to which radio control techniques may increase the safety and efficiency of yard operations.

Unions Becoming More Receptive

In considering the attitude of the unions with respect to the use of radio by the railroad industry, radio engineers anticipate that the sympathetic and constructive cooperation of the railroad brotherhoods will soon be forthcoming.

While it is natural for the leaders of the various brotherhoods to oppose any technological development that might appear to have an adverse effect on the number of employees required for railroad operation, it is thought that these leaders are becoming aware of the fact that unless the railroads employ advanced means to increase efficiency of operation, the railroads will not be in a position to meet most effectively postwar competition from other forms of transportation and thereby maintain full employment at good wages. Further, the degree of safety afforded by radio will, in the opinion of some railroad men, prove to be as important to railway labor as it will be to the traveling public. It is hoped, therefore, that frank and open discussions between the railroad operators and union leaders will make possible the wholehearted support of the brotherhoods in facilitating the successful, widespread use of radio communicating techniques throughout the railroad industry.

FCC Studying Allocation Problem

With regard to questions pertaining to Federal licensing and frequency allocation, it is anticipated that the Federal Communications Commission, other regulatory governmental agencies, and representatives from the railway and radio industries will now actively cooperate in seeking a practical solution to this problem, especially since the public has initiated a demand for use of radio by the railroads in safeguarding life and property. In this connection, it is believed that the case histories of ordnance plants will aid in proving the extent to which safety and efficiency of railway operations are increased by application of radio control techniques.

The problem of frequency allocation for proposed railway services is related directly to the manner in which radio communicating facilities are to be utilized by the railroads. If the use of radio equipment is to be placed on a limited basis to provide emergency communicating facilities only, it is possible that just a few frequencies below 100 megacycles may be utilized initially in railroad services, especially during the war period.

Central-station radiotelephone equipment at the "hump" in Proviso yard, developed by Halstead engineers for the General Railway Signal Company. Units of this general type are adaptable for installation along main-line trackage in radio-repeater or secondary-station services

However, if broad benefits are to be derived from coordinated use of radio communicating systems in routine operations, such as train dispatching, main line and yard traffic control, and other communicating services of value to railroad operators and passengers, it is believed that more frequencies, specifically assigned for routine use in railroad services, will be required.

Microwave and Induction System Possibilities

While it is recognized generally that the number of available radio-frequency channels below 300 megacycles is limited, it is pointed out that accelerated technological progress during the war has extended the useful range of radio communicating equipment to frequencies above 300 megacycles. It appears to be desirable, therefore, that any long-range plan for the application of radio to the railway industry should embody a careful consideration of the use of frequencies in the microwave range where relatively few assignments have so far been made. In this regard, it may be stated that tests conducted on frequencies above 300 megacycles have indicated that use of microwave equipment in railway radio services is technically feasible.

Utilization of the higher frequencies also appears to be desirable for the reason that, at frequencies above 100 megacycles, and in particular above 300 megacycles, directional and restricted-range radio services, limited to line-of-sight distances, become most practicable. Further, the use of directional antenna systems, wide-swing frequency modulation, and automatic relay stations along railway routes could provide railway radio facilities of an extensive nature without involving the assignment of an excessively large number of frequencies for use by the railroad industry for traffic control, emergency, and passenger communicating purposes. In this connection it is estimated that by the use of modern radio-beam communicating techniques, a maximum of 10 to 20 clear channels, on frequencies above 300 megacycles, would be sufficient to provide radio signaling circuits required for traffic control and emergency services on all main-line railway systems.

This central control unit, employed in ordnance plant radiotelephone service, is located at the yardmaster's or dispatcher's office and permits radio-equipped locomotives, motor vehicles and secondary-stations within the service area to be instantly contacted

In addition to the use of directed microwave radio channels in providing new railway communicating services, it is probable that the utilization of induction-radio signaling techniques, in which wayside conductors are employed as wave-guides or transmission lines to keep the effective signaling field within narrow zones extending along the railroad right-of-way, will prove to be of value in solving the frequency allocation problem. These restricted-range signaling methods may be of particular aid in providing supplementary communications channels along main-line trackage, in small railway yards such as those of industrial plants, and in congested terminal areas. Services of this type, however, require the use of wire conductors along railway trackage, and therefore do not have the flexibility afforded by normal space-radiation methods.

Suggested Temporary Channel Expedient

Although railroad radio equipment designed for operation in the microwave field would appear to be the ultimate answer to the problem of frequency allocation, it is understood that during the war period the Federal Communications Commission, upon proper showing that a radio service is in the public interest, will grant licenses on a Class 2 experimental or special emergency station basis to cover operation of equipment on frequencies below 300 megacycles. In this instance, it is possible that it would be necessary, at a later date, to modify the equipment for operation at higher frequencies, should the use of higher frequencies be advisable for technical reasons.

A request of the railroad industry for the allocation of frequencies for rail communications purposes, together with maintenance of a progressive viewpoint on the part of the railroad industry with regard to its future activity, should stimulate a solution to the problem of frequency allocation for general railroad use.

Technical Problems Largely Solved

In meeting the technical problems involved when applying radio techniques to mobile railway units of various types, and in effecting coverage of railway trackage extending throughout industrial or mountainous areas where shielding effects are encountered, it may be stated that solutions to these problems have already been found. These solutions include the development of practical methods of electrical noise reduction as afforded by the frequency-modulation systems developed by Major Armstrong, and the use of automatic

(*Continued on page* 210)

Medical Electronic

Basic principles of bioelectricity, a survey of present techniques, and predictions of future progress, with emphasis on electro-shock therapy, electrical anesthesia, brain-wave recording, determination of ovulation time and measurements on living tissues

THE PURPOSE of this article is to present a review of the electron arts applied to therapy, medical diagnosis and related research.

In a field indicating so many new directions, with current investigations constantly expanding the available data, it is not possible to "freeze" the information into a static picture. The literature is growing logarithmically with time, and even a bibliography would fill several volumes.

A brief list of special terms, defined according to the meanings intended in this article, appears in Table 1.

The generation of electrical charges by muscular contraction was observed by D'Arsonval in 1870, nearly a hundred years after the reverse effect was demonstrated by Galvani. During the next few decades the presence of electrical waves was discovered in connection with functions of the nerves, heart, brain and other organs in humans. More recent techniques have revealed electro-dynamic fields with distinct patterns corresponding to specific types, species and individual living organisms.

Bioelectric Currents

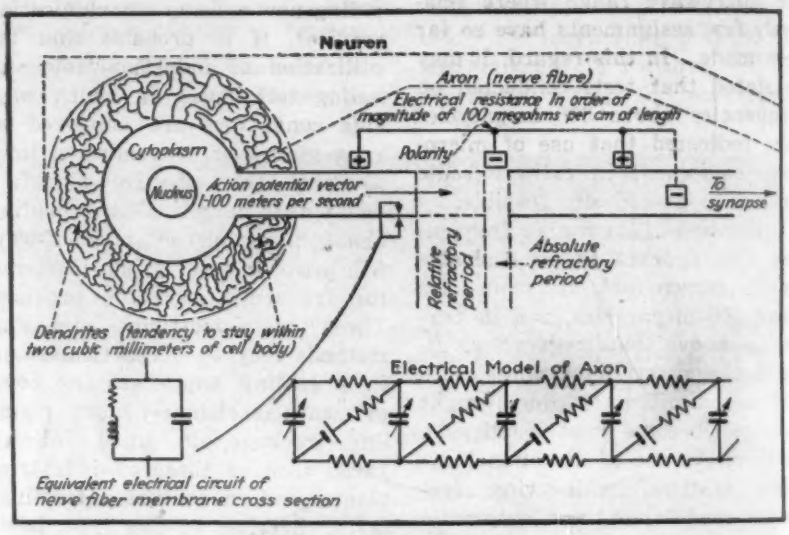
Currents produced in living organisms may be divided into five broad categories:

1. D-C Differences of Potential: These gradients appear in all living tissue, varying directly with the local rate of metabolism. The outer surface of a single cell is normally polarized with respect to its internal structures.

2. Transient Diphasic Spikes: These abrupt voltage changes appear when skeletal muscle or nerve fiber is activated. In nerve fibers such currents are called "action potentials," and often function as a stimulus to activate skeletal muscle, which in sequence produces an electrical response of similar wave form. When a nerve fiber is mechanically, electrically, chemically or otherwise stimulated, the covering membrane becomes selectively (with respect to various ions) more permeable at the point of stimulation. A local bioelectric current then flows from the positive surface to the internal area and stimulates a similar cycle in the adjacent region of the cell. In this manner a wave of increased permeability and consequent depolarization is generated and propagated so as to travel over the entire structure.

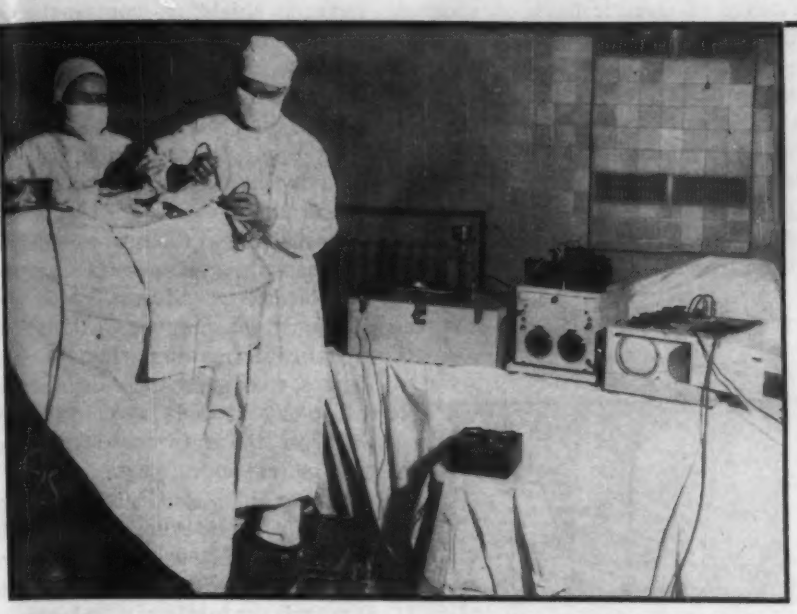
Each action potential in a single nerve fiber bears no quantitative relation to the magnitude of the external stimulus; the response is "all or none," and occurs whenever a specific minimum of energy is applied. This quantitative threshold varies in specialized sense organs for different qualitative types of stimuli. Consequently the nerve fibers of each sense organ are normally subject to excitation only by one form of energy. Immediately following local activation, the nerve fiber is incapable of response for the brief period (approximately 0.4 to 0.55 ms) necessary to effect repair. This is called the "absolute refractory period." During recovery, as the original semipermeable state of the membrane is approached, a relative refractory period occurs during which the threshold of stimulation is relatively high, returning to normal as recovery is completed.

If the stimulus is sufficiently strong and appears periodically so as to re-excite the nerve fiber early in the relative refractory period, the magnitude of the action potentials diminishes to an equilibrium which is a function of the frequency of stimulation. This equilibration may be considered as a form of fatigue, although it levels off at a definite plateau. The maximum pulse repetition rate for action potentials is about 1000 per


Neuron
Axon (nerve fibre)
Electrical resistance in order of magnitude of 100 megohms per cm of length
Cytoplasm
Nucleus
Action potential vector 1-100 meters per second
Polarity
To synapse
Relative refractory period
Absolute refractory period
Dendrites (tendency to stay within two cubic millimeters of cell body)
Electrical Model of Axon
Equivalent electrical circuit of nerve fiber membrane cross section

Schematic diagram of nerve cell, showing physical and electrical relationships

Practice and Research



Brain stimulator being used to locate areas of low threshold of irritability in the exposed brain. Currents indicating epileptic seizures, thus induced, are recorded on the electroencephalograph tape and made visible on the screen of the cathode-ray tube for the operating surgeon, while audio-frequency components are reproduced by the loudspeaker. The patient is conscious during the operation, as general anesthesia would disrupt the brain-wave patterns. Equipment shown is from Electro-Medical Laboratory, Inc., Holliston, Mass.

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second, and the velocity of conduction ranges from 1 to 100 meters per second, averaging around 30 mps. It should be noted that the considerable length of many axons and the relatively slow travel of action potentials makes it possible for large differences in activity to appear at various points simultaneously in the same cell. An action potential starting at one end may encounter and be terminated by an absolute refractory period further along the fiber which resulted from a second stimulus originating even later in time. This may have some importance in connection with masking effects produced by the series-parallel connection of auditory nerve endings to certain hair cells in the inner ear.

Note: The point of connection between neurons (synapse) presents a number of unsolved mysteries. Some evidence indicates the release of a chemical mediator (sympathin, acetylcholine, etc.) at the nerve endings, which functions to activate muscle tissues and may be the mode of transmission at synapses. The transmission time across synaptic junctions ranges from 0.5 to 3.0 milliseconds.

3. Semi-Rhythmic Wave Forms: Smooth muscle moves with a slow undulation that generates a corresponding electrical wave form. This type of electrical manifestation accompanies the regular contractions and relaxations of the intestinal tracts during digestive processes.

4. Microphonic Currents: The so-called "cochlear response" from the inner ear is an electrical cur-

TABLE I. DEFINITIONS OF MEDICAL TERMS USED IN THIS ARTICLE

CELL: The unit of structure for living organisms. A cell consists of a nucleus, which directs the activity, and cytoplasm, which surrounds the nucleus and carries out the activity. Semi-permeable membranes separate the nucleus from the cytoplasm, and the cytoplasm from its environment.

CYTOPLASM: The viscid, sticky substance which does the work of the cell. It contains many structural variations locally and generally, and is composed of carbohydrates, fats and proteins, as well as many special enzyme systems, minerals, water, salts, etc.

NEURON: A cell specialized by its cytoplasmic form and structures for conducting a nerve impulse.

NERVE IMPULSE: A conducted tendency to excite activity in the next unit of a chain; its energy has electrical, chemical and thermal manifestations and is derived from the local area where it appears at a specific moment of time.

DENDRITE: The branching arms of cytoplasm in the neuron which remain within two cu mm of the cell body in which the nucleus is located; they receive the nerve impulses from other neurons.

AXON: The single structure reaching from the cell body of the neuron which may extend for distances up to four or five feet, terminating upon the dendrites and cell body of another neuron or some other type of specialized cell (effector organ)

MYELIN SHEATH OR MEDULLATION: The fatty coating which covers axons requiring speed of action; the velocity of propagation of the nerve impulses is related to the thickness of the fatty sheath.

INNERVATION: The nerve supply to clusters of cells of the same type and function.

SYNAPSE: Originally a functional concept of the special characteristics of the brain and spinal cord in contrast to axons. These include: (1) one-way conduction; (2) gradation of response to strength of stimulus; (3) easy fatigueability; (4) summation of impulses; (5) inhibition or suppression of excitation. Used in the anatomical sense in this paper to refer to the contact of the specialized endings of axons with the dendrites or cell bodies of other neurons.

OVULATION: The process of discharging an egg cell (ovum) from the ovary into the conducting tubes of the uterus.

STIMULUS: A quantity of energy which when applied will evoke a response.

SENSE ORGAN: A cell or group of cells specialized in responding to a particular form of energy (stimulus) at a lower threshold than other forms of energy.

SKELETAL (VOLUNTARY) MUSCLE: A mass of cells capable of responding to nerve impulses by a rapid, vigorous shortening (or increased tension); this is the type of muscle with which voluntary movements are produced. Under the petrographic microscope the cytoplasm of skeletal muscle shows alternating transverse bands of isotropic and anisotropic substances.

SMOOTH MUSCLE: Layers or sheets of small spindle-shaped cells which enclose all hollow internal organs (stomach, intestine, bladder, genitalia, etc.) and most blood vessels; they are capable of adapting their dimensions within wide limits to changing conditions without increased tension, and are characterized by slow (usually rhythmic) contractions; smooth muscle is not generally subject to voluntary control.

CARDIAC MUSCLE: A special type of cellular construction associated with the action of the heart, with characteristics between those of smooth and skeletal muscle.

rent which follows the frequency and amplitude pattern of the sound energy stimulus with considerable fidelity. This is the only phenomenon where living tissue has been demonstrated to function as a direct ratio transducer of complex energy patterns. The optic mechanism may have some similar characteristics.

5. Continuous Rhythmic Wave Forms: In the central nervous system (brain) the electrical component of continuous activity is omnipresent. These brain waves are observed as a steady flow of rhythms subject to many interpretations. The correlations with pathological conditions are based on empiric knowledge.

The vast majority of information about all these currents has been obtained since the advent of vacuum-tube amplifiers. Special equipment of various kinds has been developed for studying specific manifestations. There is a considerable trend today to combine a variety of simultaneous measurements and integrate the resulting data into a coordinated diagnosis. Considerable work along this line was reported by Dr. Lynn in the January, 1944, issue of ELECTRONICS.

Electrodynamic Field Patterns

It is still difficult to state the extent to which the organization and growth of living cells is directed by associated electric fields. The phenomena appear to be inextricably intermingled, each dependent on the other for existence and orientation, and confirmatory evidence for the basic inter-relationship has been clearly established.

Successful predictions regarding the axis along which a central nervous system would develop have been based on measurements of voltage differences existing in the eggs of frogs and salamanders. Studies of cancer in the breasts of mice have shown that a measurable change in field strengths indicates the onset of wild cell growths before they can be observed by touch. Mice susceptible to cancer appear to have characteristic electro-dynamic fields in their breast structures which differ observably from cancer resistant types. Measurements made on unfertilized eggs, on seeds and plants, on wide varieties of living systems, have all seemed to verify conclusively the interdependent existence of electric fields in connection with growth, change and all cellular activity.[1,2] Experiments are indicated to determine whether the growth of living systems can be deliberately influenced by exterior applications of electro-dynamic patterns, but little, if any, evidence of a conclusive nature has been presented from this approach.

Certainly it is an amazing mechanism that controls the growth of living organisms with complex biological designs, in the midst of intricate chemical changes, with so little inconsistency. It may well be that this fundamental organization is accomplished by electrical means.

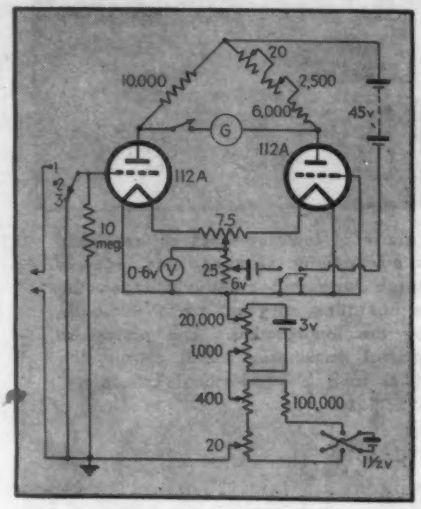


FIG. 1—Circuit diagram of Burr-Lane-Nims vacuum-tube microvoltmeter, used for measuring extremely small potentials in living-tissue structures during medical research and for determining ovulation time in experiments with artificial insemination. Both tubes are used with bases removed. (Yale Journal of Biology and Medicine)

The mapping of direct voltage gradients in living structures presents many special problems, and requires an instrument of sufficiently high input impedance to draw a minimum of current from the area under investigation and be reasonably unaffected by varying resistances. Quadrant electrometers are ruled out by many difficulties involved in their operation, as well as high sensitivity requirements.

The Burr-Lane-Nims vacuum-tube microvoltmeter[4], diagrammed in Fig. 1, solves these problems. This instrument requires little associated shielding, contains standard radio parts and is conveniently portable. The circuit is a bridging arrangement using two type 112-A radio tubes with a special battery bias supply for the grids, which is adjusted to the "floating grid" potential.

Associated equipment consists of an accurate galvanometer and reversible silver, silver-chloride electrodes which may be designed for microscopic manipulation. A number of necessary precautions and calibration procedures are fully outlined in the referenced paper on this instrument.

One of the most dramatic demonstrations of the existence of an electro-dynamic field has been produced by placing on a turntable a vessel containing a salamander immersed in salt water. When rotation takes place between electrodes connected to a galvanometer, a sine-wave output may be recorded, showing that the salamander is functioning as the living armature of a dynamo, proving the presence of an electric field.[5] All of this excites great interest, and the answers to many basic riddles of organization may well be established as a result of such research.

Electro-Shock Therapy

Of more immediate practical importance is the application of electronic devices to therapy and diagnosis. The use of diathermy machines is so common today as to be familiar to nearly everyone. It is of particular importance that acceptance of new techniques is rapid, and the medical practitioner is more eager to take quick advantage of developments than ever before in history.

An example is the speed with which the use of electric shock has spread in the treatment of psychotic disorders. Although first demonstrated only five years ago (Rome, Italy, 1938), the literature already contains more than 150 papers on this subject.[6] Commercial apparatus is available, and most major hospitals have trained operators on their staffs. Electric

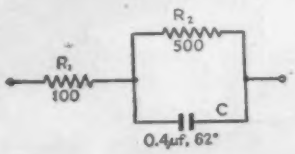
shock offers many advantages of control in convulsive therapy, and has been adopted widely because of the relatively low incidence of post-treatment complications. Among the desirable results from electric shock therapy is the immediate unconsciousness produced upon application of the stimulus, and the freedom from unpleasant sensations such as are associated with recovery from metrazol injections. Of equal interest is the amnesia the patient has for the treatment, which improves his cooperation in successive applications. This is of particular importance because many practitioners regard thirty or more convulsions as necessary for permanent cures of certain disorders.

Manufacturers of this equipment stress the incorporation of safety features, such as protective circuits to prevent application of treatment currents prior to determining the proper amperage and duration of the shock. Automatic timers ranging from 0.1 to 0.5 second are included, and safety switches prevent the possibility of excessive current surges.

When the 60-cycle shock current is applied, it is important that the electrodes be in firm contact with the temples. In most cases 400 to 450 milliamperes applied for from 0.2 to 0.3 second will produce general convulsions, but the exact treatment required varies with the individual patient.

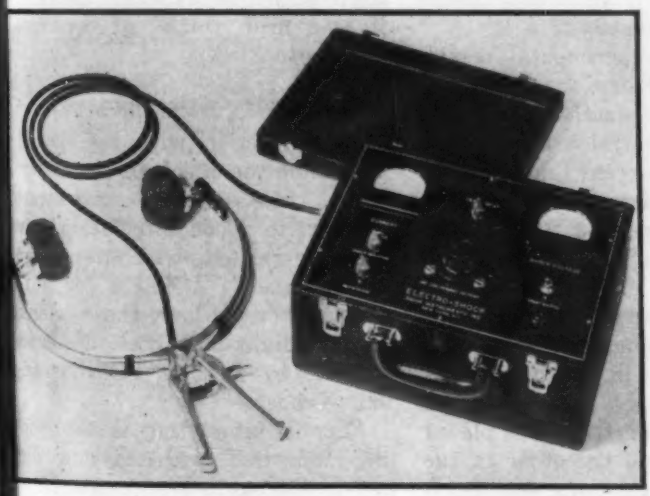
The "why it works" questions about electric shock therapy are completely unanswered. Conjectures, which have little if any basis in definite experimental evidence, range from the belief that organic changes are produced in the brain (possibly destroying higher nerve centers) and the theory that abrupt overloading of the nerve circuits reestablishes proper connections. The brain centers it is desired to affect have not been specifically located. In fact, beyond the bare knowledge that electric shock produces convulsions that are beneficial in certain psychotic disorders and that current magnitude and duration are determining factors, very little is definitely known about this type of therapy. A great deal of experimental work under controlled conditions is needed.

Electric shock is a powerful tool, and as additional experimental work goes forward, an increased understanding may expand the use of this type of therapy. It is interesting to note that early workers based the calculation of treatment currents on d-c resistance measurements and were annoyed and perplexed at the apparent anomalous failure of the treatment current to behave in accordance with Ohm's law. It has been shown that the equivalent circuit approximates



in which C represents the reactance introduced by the polarizability of living tissue. When such tissue is highly stimulated, the polarizability approaches zero and R_2 falls to a relatively low value, essentially short-circuiting C and reducing the effective resistance to a figure far below the measured d-c value. To circumvent this difficulty, some instruments have built-in circuits with which the *effective* resistance is calculated on the basis of a high-frequency (approximately 7000 cps), low-intensity current which is readily passed by C.[7]

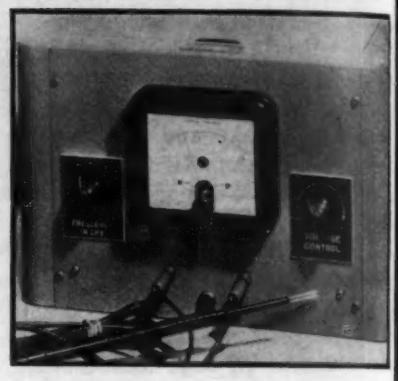
The frequency for the test current must be selected to avoid the pararesonant point of the nerve cells, in order to eliminate any possible sensation by the patient during the test. Actually, d-c resistance measurements change with the manner of electrode application, and voltages vary accordingly. Conversely the electrode



ABOVE—Electro-shock therapy unit made by Rahm Instruments Inc., New York. Balls of steel wool held by locking tongs serve as electrodes

RIGHT—Electro-shock therapy equipment in use. This instrument, made by Offner Electronics Inc., Chicago, uses flat metal electrodes held in position by a soft, flexible band around the head

Application of small lead electrode to the scalp with collodion and a conductive paste, for brain-wave recordings. The scalp is not pierced, nor is it necessary to cut away any hair. This photograph was taken in the Brain-Wave Department of Harper Hospital, Detroit



Cortical stimulator unit made by Rahm Instruments, Inc. When the electrodes are applied to the exposed surface of the brain, the muscles controlled by that section will move and thus identify that cortical area. An RC oscillator using a gaseous triode and followed by an a-f amplifier generates 7.5, 15, 30, 60, 90, 120, 240, 480 and 1000 cps, with the saw-tooth output voltage being variable from 0 to 10 v

technique does not greatly change the effective resistance measured at high frequencies, nor does it appear to alter appreciably the current required for treatment. It is the current, and not the voltage, which produces the convulsions. Hence, variations between techniques and patients may result in widely differing voltages, but data on current values can be correlated without precise reference to other controls.

Electro-Narcosis

Development of electro-shock therapy has led to revived interest in electrical anesthesia. Relatively few papers are available on this subject, but experiments date back over fifty years. Shortly before the turn of the century an operation was reported as successfully performed under local electrical anesthesia. Both direct and alternating currents have been used, but unfortunately the results reported by various investigators differ so greatly that few valid conclusions can yet be assumed..

One set of experimental results from tests on frogs, rats and dogs indicates the production of a reflex block due to central action by application of a current that approximates one milliampere per sq mm of spinal cord cross-section.* Complete anesthesia was produced and maintained for eight hours in one dog, and repeated periods of several hours each produced no observable histologic effects in the spinal cords of rats and dogs. In the work with dogs, one electrode was placed in the mouth and the other in the anus. The d-c resistance was measured at a rather surprisingly low value, around 500 ohms. Twenty volts was required to obtain the 45 ma of current necessary for anesthesia. Some experimenters report inability to duplicate these results. Alternating-current tests have produced data with somewhat greater agreement between investigators.

The desirability of producing anesthesia electrically includes a number of obvious advantages of control and convenience. Certain direct-current experiments have shown the effect to be reversible. It is believed, in general, that a-c is less likely to cause serious damage such as is associated with the polarization of delicate cellular structures. As in electroshock therapy, the theories with regard to electrical anesthesia are numerous and varied. No one knows definitely "why," and careful experimental work is needed to exhaust the possibilities. This may have no practical value, or the solution might provide an inestimable contribution to mankind. Certainly it is a field worthy of continued exploration.

Impedance Measurements

In connection with research to determine the effects of centrifugal force in aircraft maneuvers, changes in blood circulation have been correlated with tissue impedance data. A device for automatically recording these effects during flight has been developed at Yale by Drs. L. F. Nims and Jan Nyboer.

Equally interesting is the work in connection with thyroid disorders started in 1933 by Dr. M. A. B. Brazier,* now of the Massachusetts General Hospital. As discussed under electro-shock therapy, there are many difficulties of control in making d-c resistance measurements on living tissues. Even slight changes in electrode technique often produce large devia-

tions. Impedance to alternating currents can be determined with greater accuracy, and a definite correlation has been found with thyrotoxicosis. In cases of goiter it is important to distinguish between toxic activity of the thyroid gland and non-toxic conditions. Previously diagnosis has been based on basal metabolism rates. B. M. R. measurements involve hospitalization, fasting and many variables.

In these investigations the human body was considered as an irregularly shaped quantity of dielectric substance. The dielectric loss angle δ, or the correlative power factor angle ϕ, ($\delta = \frac{1}{2}\pi - \phi$), either of which may be considered as the "impedance angle," are quantitative measurements which eliminate the variable factors of size and shape. The angle of the impedance vector may be measured in terms of either reference, i.e., with respect to pure resistance or pure capacitance vectors, because clinical results are concerned only with deviations from a standard.

Using simple, portable devices consisting of an oscillator, a variation of the Wheatstone bridge and a heterodyne unit (in order to make possible the use of frequencies above the audible range), the impedance angle of a human body may be measured in approximately five minutes. No previous conditioning of the patient is required. Extensive statistical programs have determined the validity of this measurement in terms of the B. M. R. in thyrotoxic patients.[10] An additional use for this method is found in the control of thyroid dosage for treatment of mental disorders.[11]

Studies of Ovulation

Conception can occur only during a brief number of hours following ovulation, and for this and other reasons a knowledge of the time at which the ovum is released has importance in gynecology. Characteristic electrical changes were reported in 1935 in connection with ovulation in rabbits.[12] Subsequent investigations in humans appeared to confirm the accuracy of this correlation. Recent studies[13] have involved artificial insemination of previously infertile women at the time indicated by the changing potential associated with ovulation. Although some of these women had

(*Continued on page* 356)

TABLE II. ELECTRO-BIOLOGICAL MEASUREMENTS

Phenomena	Observing Instruments	Order of Magnitude in Millivolts	Physiologic Source	Application of Knowledge
Voltage generated by heart action.	Electrocardiograph (EKG Recordings.) Special electrode techniques recently developed permit flexible observing viewpoint [21].	1.0–2.0	Cardiac muscle.	Diagnosis; confirmation of diagnosis; indication of pathologic disturbance to normal functions.
Contraction of skeletal muscle generates abrupt voltage transients.	VT amplifier with associated recording instruments.*	0.05–10.0 (50.0**)	Skeletal muscle.	Treatment for infantile paralysis may be checked to indicate extent of progress. Diagnosis and study of muscular pathology.
Digestive activity raises stomach voltages. The voltage changes appear to vary in relation to normal, ulcerous and cancerous condition.	VT amplifier with associated recording instruments.*	0.1–50.0**	Smooth muscle.	Experimental work indicates the possibility of developing an accurate ulcer and cancer diagnostic method.
If nerves are anesthetized or severed, d-c skin resistance rises. Areas of human skin have been mapped and measurements compared to correlate normalcy between individuals.	String galvanometer.			Determination of damaged nerves in fractures. D-C skin resistance measurements are also studied in connection with diabetes, circulatory conditions, Reynaud's disease, etc.
Skin impedance to alternating currents varies in different areas under changing conditions. Correlative studies indicate relationship of skin impedance to blood circulation.	A-C bridge circuits.			Self-recording instruments have been devised to indicate effects of centrifugal force in aircraft maneuvers on blood circulation.
Voltage measurements on breasts of mice change in advance of cancerous growths. Patterns appear different in mice that are inherently susceptible and those naturally resistant to cancer. Changes and growth in cell structure are accompanied (possibly controlled) by associated changes in electrodynamic fields.	VT Microvoltmeter.	Few microvolts.	Injury potentials to cell structures or organizing electro-dynamic field mechanism.	Diagnosis of cancer susceptibility; advance warning of wild cell growths. Investigation may assist in development of therapeutic methods.
Ovulation in animals and humans is accompanied by a voltage change.	VT amplifier with associated recording instruments.*	5.0–25.0	Metabolic changes, rupture of tissues, etc.	Determination of ovulation time in humans is of interest for many reasons. It has been used to determine proper moment for artificial insemination of previously infertile women.
Reptile eggs, even previous to fertilization, show variations in voltages for different surface areas.	VT Microvoltmeter.	Few microvolts.	Electro-dynamic fields associated in structural relationships with intracellular organization.	Successful predicitions based on these measurements have been made as to the axis along which nervous centers would develop. Investigations may lead to a better understanding of the forces governing the creation of living organisms.
Normal and abnormal physiology of the brain is accompanied by typical brain wave patterns.	Electroencephalograph (EEG Recordings).*	0.01–1.0**	Continuous functioning of brain cells generates electrical wave forms.	Diagnosis of epilepsy. Diagnosis and location of brain tumors, blood clots, etc. Studies of behavior conditions.

* These devices are used in connection with a wide variety of writing recorders of magnetic, thermal and crystal types, as well as oscilloscopes and oscilloscope motion picture cameras.

** 50.0 millivolts is the theoretical maximum for action potentials, and the lower order of magnitude in practice results from shunting circuits. With amplifiers of special design, spikes (transients) in action potentials of nerve fibres have been observed well above the 100-millivolt range.

Fabricating Wood A

R-F heating is extensively used in the production of flat laminated stock. It is also coming into favor for the fabrication of curved spars and other parts of the structural type. This article discusses experimental manufacture of thin coverings such as those that constitute wing and fuselage surfaces

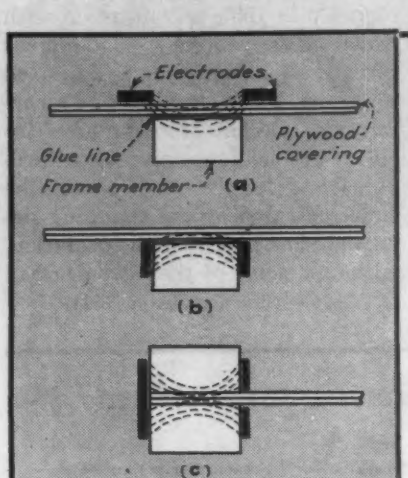


FIG. 1—Several arrangements of electrodes for gluing thin plywood to a frame member by utilizing so-called "stray-field" heating. In (b) and (c) the greater conductivity of the glue line causes a concentration of current

IN THE FIRST PART of a previous article[1], methods of adapting radio-frequency heating to the production of curved laminated wood aircraft parts—particularly *parts of the structural type* such a sthose used in the aircraft frame—were discussed at some length.

Radio-frequency heating may also be used eventually in the production of thin plywood coverings such as those which make up the *wing and fuselage surfaces* of wood aircraft. This use of r-f heating is still in the development stage. A considerable amount of experimental work, however, has been carried out and the results lead to the conclusion that while r-f heating may not be immediately applicable to the manufacture of these relatively thin sections, it does have definite promise for the future.

As in the case of the structural-type parts previously discussed, it is obvious that the greatest advantages will result only when r-f heating is applied to quantity production. Whether wood aircraft production will ever reach the quantities necessary to justify the use of r-f heating on a large scale is a question. However, it is almost certain that plywood parts of a similar nature will find many uses after the war and that some of these uses will require such parts in large quantities. The start which has been made toward developing r-f heating techniques for this type of application is, therefore, of interest beyond the present concern with wood aircraft.

FIG. 2—Experimental plywood door for a two-engined bomber-trainer. Made from five plies of 1/16-in. veneer, this door is typical of "semi-molded" sections

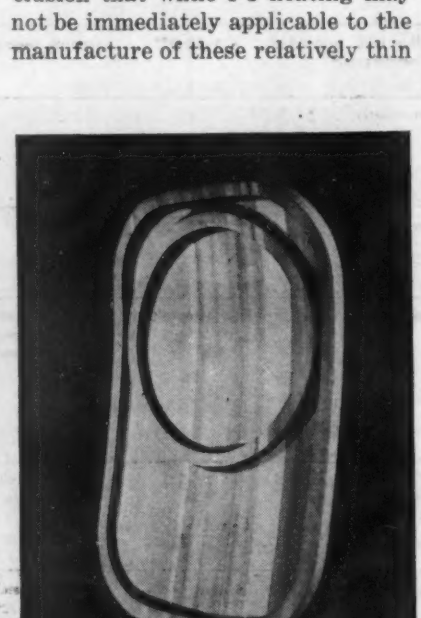


FIG. 3—Rear view of the door shown in Fig. 2. The frame is cut from a piece of 1¼-in. thick plywood formed to the proper curvature at the time of gluing

Making Parts From Flat Sheets

There are three more or less distinct types of construction used in making fuselage or wing sections for wood airplanes. In the first of these a strong wood frame is the essential element. Over this frame thin sheets of flat plywood are bent and tacked or glued in place. This type of construction is similar to that of the so-called "wood-and-fabric" small planes made in pre-war days except, of course, that the covering is thin plywood instead of fabric. For lack of a better name it will be referred to as the "frame-and-covering" type of construction.

There are two possible uses of r-f heating in this type of construction. Both are somewhat outside the intended scope of this article and both have been at least partly described before. For the sake of completeness, however, they deserve to be mentioned.

Aircraft "Skins"

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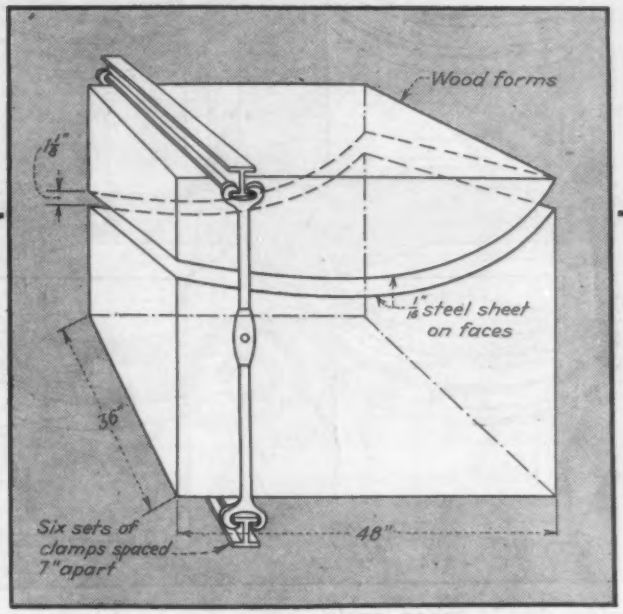

FIG. 4—Arrangement of forms and clamps used to make the thick piece from which the frame of the bomber door shown in Figs. 2 and 3 is cut. The steel faces of these forms were used as electrodes in adapting this operation for the use of r-f heating

The first of these applications is in the production of the large, flat sheets which are used as covering material. Since these sheets are very thin—from 1/20 in. to ¼ in., according to use— they can be made quickly and satisfactorily in hot-plate presses. At the present time, so far as is known, all so-called "aircraft-quality" plywood is made by this method. There is, however, at least one large plywood manufacturing plant in operation today in which r-f heating is being used for the mass production of large, thin sheets of ordinary Douglas-fir plywood.[2] If this operation—in which the cost of the final product is much lower than that of "aircraft-quality" plywood—is economically justified, then it seems at least possible that eventually all plywood will be made this way.

The second possible application of r-f heating to the frame-and-covering type of construction is in "tacking" or gluing the covering sheets to the frame. At the present time this is mostly done by cold-gluing, the sheets being held in place during setting by "nailing strips," which are narrow wood strips tacked along the edges of the sheet.

Conceivably the experimental r-f spot-gluer, which has been previously described[3], could be used for this purpose. By "tacking" the sheets down to the frame with this spot-gluer the necessity of placing and removing "nailing strips" would be overcome and the holes in the skin caused by the nails would be eliminated. No great time saving would be occasioned, of course, since only the "spots" would be immediately glued and the rest of the glue would still be "cold-set," which means a matter of hours. This use of the spot-gluer has not been given a complete trial and there remains a question as to whether spot-gluing will result in sufficient pressure (during the subsequent cold-setting period) to obtain full strength of the bond between sheet and frame.

A more promising method, so far limited to small pieces, is the use of so-called "stray field" heating. This consists of placing two thin strips of copper along the joint to be glued, in one of the ways shown in Fig. 1. These strips are connected to the output terminals of an r-f generator. While the glue-joint does not lie directly between the electrodes, it is usually sufficiently in the field so that the necessary heating results. In some cases the higher conductivity of the glue line provides a current concentration which is of considerable advantage. A production operation of this type was recently described by John Dreyer of Duramold Corporation in a paper before the Radio Club of America[4]. Similar applications have been described by Bilhuber and Godfrey[5]. It is desirable to note, however, that in many instances gluing operations of this kind can be satisfactorily accomplished by the use of simple resistance-heater strips.

Making Semi-Molded Parts

Following the frame-and-covering type of construction, in the natural order of development, comes a second type of wood aircraft construction—usually called "semi-monocoque"—in which a somewhat lighter frame is used and the plywood surfaces themselves are so designed as to give additional strength to the structure. This is accomplished by shaping or molding the plywood coverings to final form at the time the separate veneers are glued together. When these shaped surfaces are placed over the frame and securely glued to it at all points, they tend to hold the whole assembly together rather than to be held by it, as when flat sheets are used as coverings.

In the semi-monocoque type of construction the wing and fuselage surfaces are usually divided into a number of components which are

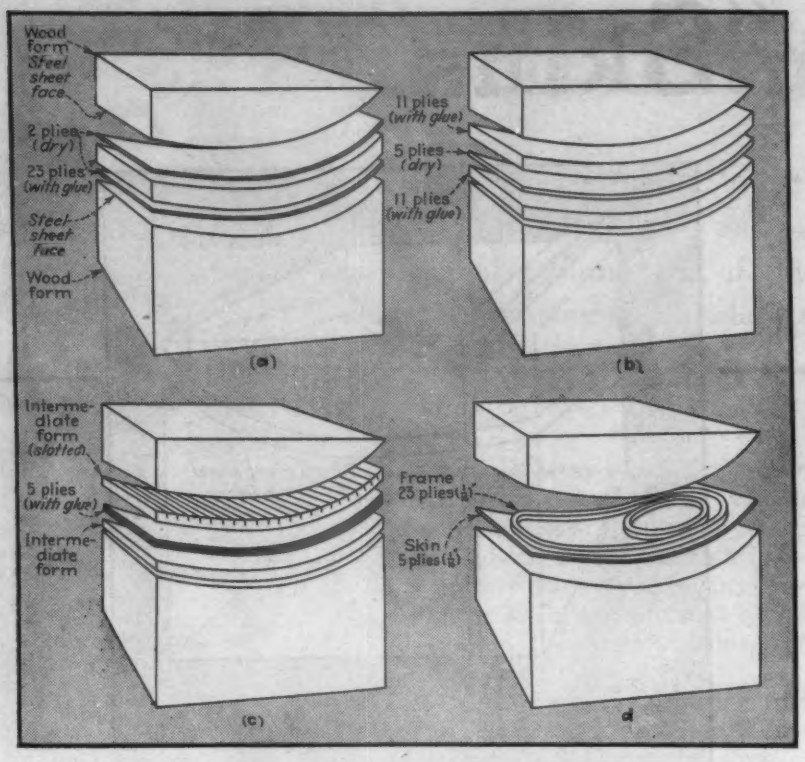

FIG. 5—Four steps in making complete bomber door by r-f heating method: (a) gluing 23 plies of 1/16-in. veneer to make frame piece; (b) gluing two packages of 11 plies each to make intermediate cauls; (c) using intermediate cauls to glue 5 plies for "skin" of door; (d) gluing frame to "skin"

formed separately. The wing, for instance, may consist of a leading-edge section, two slightly curved wing surfaces and a wing tip section. The fuselage will ordinarily be made up of half a dozen or more separate pieces. Some of these individual sections will be of simple curvature or of very slight double curvature. These can be made from flat veneer, providing the individual veneers are quite thin. Such parts are usually referred to as "semi-molded" (to distinguish them from the "full-molded" parts which, as described later, are made up from narrow strips of veneer).

In Fig. 2 and Fig. 3 are shown the front and back of an experimental door for a two-engined bomber-trainer. This door consists of a heavy frame which is about 1¼ in. square and is formed to the outline of the door, together with a preformed plywood "skin" made from five sheets of ⅛-in. veneer. The frame is routed out of a piece of formed plywood 1¼ in. thick. The arrangement of forms and clamps shown in Fig. 4 is that which was previously used in making this thick piece by cold-gluing methods. These forms are similar to those previously described[1]; that is, they are made of wood and provided with ⅛-in. steel facing plates on the inside surfaces. By using these steel plates as electrodes it is relatively easy to apply r-f heating to this gluing operation. Not only is the thick "plywood" piece from which the frame is cut made with r-f in 2½ minutes, as compared to 8 hours by the cold-gluing method, but also the "skin" for the door is made with r-f and, finally, the skin is attached to the door by means of r-f heating.

The method followed in making the completed door by the r-f heating method is illustrated in the several sketches of Fig. 5.

In the first step 23 plies, each ⅛ in. thick, are glued together (and simultaneously formed to the required shape) as shown in Fig. 5a. (The thick plywood piece shown in Fig. 6 is the result.) From this piece the frame of the door and the inner circle (which forms a frame for a window) are cut by routing.

The second step in the process is to make up two intermediate forms or "cauls" which will act as space fillers and thus allow the same main forms to be used in forming the "skin" for the door. To do this two packages of 11 plies each are glued up as shown in Fig. 5b. (The result of this operation is the two formed caul boards shown in Fig. 7.) The two caul boards so produced are used to fill in the space and thus make the forms fit correctly.

The skin itself is glued up from five plies as shown in Fig. 5c. The operation of gluing up the skin is

FIG. 6—Thick plywood piece from which door and window frame are routed. Glued as shown in Fig. 5a

FIG. 7—Intermediate cauls used in gluing skin. They are made by means of r-f heating as shown in Fig. 5b

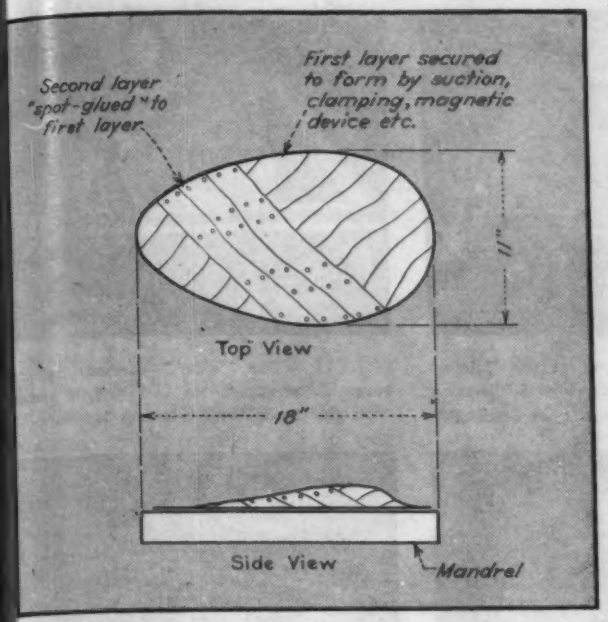

FIG. 9—Top and side views of mandrel during process of "wrapping" veneers used in forming the "blister" piece referred to in the text

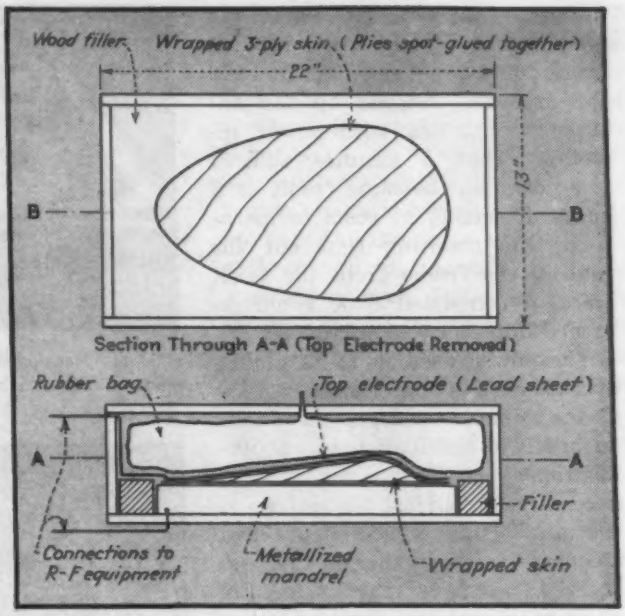

FIG. 10—Arrangement for curing the "blister" piece by means of r-f heating. Pressure is applied by inflating the rubber bag to approximately 50 lb

much more critical than that of gluing the thick piece due to the fact that it is much thinner and hence any small misfit makes for a greater percentage error and a correspondingly greater difference in pressure over the area of the piece. For this reason it was found necessary to position the caul boards very carefully. A further advantage was gained by cutting saw-slots in the top caul board every inch or so along its length.

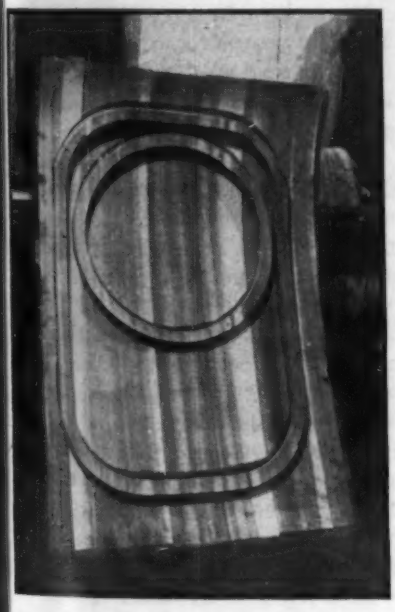

FIG. 8—Frame glued to skin and ready for trimming and sanding

This gave the board considerable flexibility and thereby tended to provide a pressure-equalizing effect.

As the final step in producing the completed door, the skin formed as above and the frame and circle routed from the thick piece made first are placed in the forms again as shown in Fig. 5d and r-f power applied to join them permanently together. After this final gluing operation the assembly needs only to be trimmed and sanded and it is ready for final finish. (The frame and skin, which have been glued but not yet trimmed, are shown in Fig. 8.)

In each of the four gluing operations outlined above the radio-frequency connections are made to the steel face plates of the main forms. Thus all of the material placed between these plates is heated in each instance. This represents a certain waste of power but has the advantage that tuning and power adjustments of the r-f generator are the same in each operation. This is an important consideration where the equipment is to be operated by inexperienced personnel.

R-F Equipment

The r-f feed arrangement used is exactly the same as that used in gluing the laminated fuselage rings previously[1] described. Essentially this consists of a two-wire transmission line from the generator to the two steel face plates which form the electrodes. (In permanent installations a concentric transmission line is used in order to reduce radiation) Tuning is accomplished by an adjustable tuning stub connected in parallel with the load. With a spacing of 1¼ in. between forms, as used in the four operations described above, a frequency of 8 Mc was found most convenient. If only the "skin" were to be heated in the one operation—as by using additional electrodes next to the "skin"—the load capacitance would be so great that a lower frequency, probably 2 or 3 Mc, would have to be used. On the other hand, if an attempt is made to use the lower frequency in making the thick piece, it is found that an impractical amount of tuning inductance is required and, moreover, the voltage gradient across the load is high enough that flashover may occasionally occur. For this reason as well, therefore, the arrangement in which all the material between the forms is heated is much the best.

With this method consistently good results were obtained. Any of the four gluing operations could be completed in an average time of 2½ minutes of actual heating. To insure positive results it was found desirable to apply power for 2½

minutes (during which time the temperature of the wood rose to about 230 deg F) and then to leave the material clamped up for another 2½ minutes with power removed. Thus 5 minutes sufficed to accomplish the same result as 8 hours of setting at room temperature. Not counting time out for routing the frame from the thick piece, a completed door could be turned out every 15 minutes.

The power used in these gluing operations was approximately 8 kw at the generator output terminals. In order to accomplish the above-mentioned heating times it was necessary to readjust the setting of the parallel inductance as the load changed during the heating period. As the reactance may change as much as two-to-one during the cycle, and as the circuit is quite sharply tuned, the current through the load would drop off markedly if this were not done, and a much longer heating time would be required. This is one drawback of the simple and otherwise desirable r-f feed arrangement used here. There are several possible ways to overcome it. One is to use an arrangement in which the load is simply connected across the tank circuit, or a part of it, so that the frequency of the generator, assuming it is a self-excited oscillator, changes with the load and thereby keeps itself in tune. Unfortunately, this arrangement requires the use of low frequencies for other than the smallest loads, and low frequencies invite trouble with flashover. Moreover, the use of oscillators which drift through a wide range of frequencies during the cycle is questionable engineering. If the practice becomes widespread it will be certain to result eventually in a difficult interference situation.

Another possible solution has been suggested by Hoyler and Bierwirth[6]. This consists in placing in the line a matching section which is so designed as to minimize the effects of load changes.

Making Full-Molded Parts

Wood, unfortunately, cannot be stretched or drawn. Therefore, where the forming of parts for wood aircraft requires pieces having a compound curvature, it is

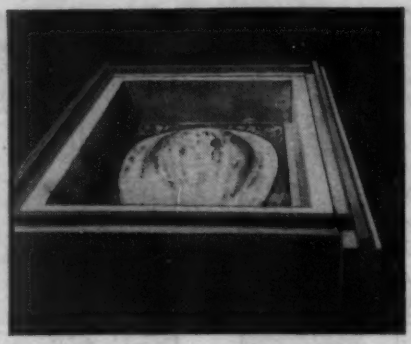

FIG. 11—Metallized mandrel for "blister" piece, mounted in box used for r-f heating. Metallized layer forms bottom electrode

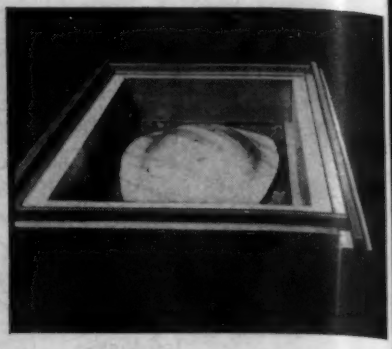

FIG. 12 — The "skin", formed by the veneers "wrapped" as in Fig. 9, is placed on the metallized mandrel for curing

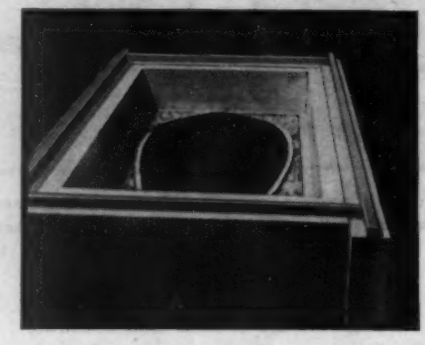

FIG. 13—Upper electrode, consisting of formed lead sheet placed over the "skin" which is to be heated

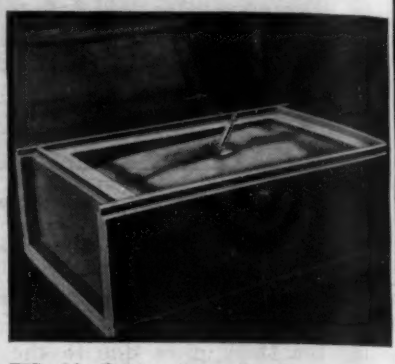

FIG. 14—Rubber bag placed over top of lead sheet. After the box is closed the bag is inflated to provide the required pressure

necessary to resort to a third and rather complicated method of construction. This involves molding of these parts by what is commonly called the "rubber bag process." This process has been described in some detail by the author in a previous article in ELECTRONICS[5] and at length in various other journals.[7, 8, 9] Essentially it consists of the following steps.

First, a mandrel is made, usually of wood or plastic. This is a male form carefully shaped to the precise contours of the fuselage or wing surfaces to be made.

Second, narrow strips of thin veneer to which a resin glue has been applied are fitted or "wrapped" on this mandrel as shown in Fig. 9. Each strip is tailored by trimming or slotting so that it fits the form snugly and its edge is tight against the edge of the preceding strip. At the present time these strips are usually secured to the mandrel with staples. From three to as many as nine layers of veneer may make up the "skin" which is "wrapped" on the mandrel in this way.

The third step in the process is to place the mandrel and wrapping in a rubber bag from which the air is then evacuated.

Next the whole package—i.e., mandrel, wrapped-skin and covering rubber bag—is placed in a large pressure chamber called an "autoclave." Steam, hot water or hot air under pressure is then introduced into the autoclave. The resulting combination of pressure and heat serves to set the glue and thereby weld the strips of veneer into a single strong piece of the desired shape.

While this process of making "molded" wood parts is, with a number of variations, in wide use today, it has many acknowledged drawbacks. One of these is the use of staples which leave small holes in the "skin," often puncture the bag and, to some degree, limit the slight shifting of the veneers under pressure which is desirable in obtaining a fully stressed piece. The r-f spot-gluer mentioned above can be used in place of the staples, as has been previously described in ELECTRONICS[5].

An even greater disadvantage in the bag method is the necessity of using an autoclave. Not only is

the autoclave method slow, but also it is inefficient and somewhat dangerous. Hence, even though the use of r-f heating for thin pieces, such as these aircraft "skins" represent, is at first glance not too promising —on the theory that external heat can penetrate thin sections quickly and hence "heating the inside" is of no advantage—it turns out on further study that it may yet be found of advantage in this particular case. A few experimental tests of the use of r-f in making full-molded parts have been made. One method which yielded fairly good results will be described.

The piece chosen for this test was a small streamlined "blister" used on a well-known bomber-trainer. While this piece is of small size, it has a sharp double curvature and is otherwise typical of the sections ordinarily "molded" by the bag method. Since r-f heating applications which look good under idealized conditions in the laboratory often come to grief when moved to the factory, an attempt was made to reproduce factory operating conditions. A regular mandrel was used and the layers of veneer were fitted or "wrapped" on this mandrel by one of the regular girl operators.

Three layers of 1/48-in. veneer were "wrapped" on the mandrel using the r-f spot-gluer previously mentioned. Figure 9 shows the position of the spot-glued points on the several layers of veneer.

In Fig. 10 is shown the r-f heating box used to "cure" the skin wrapped as above. This is a heavy wood box in which the mandrel is placed as shown. A rubber bag is arranged so that after the lid of the box has been clamped shut the bag can be inflated, thereby providing the pressure required to press the veneers tightly against the mandrel and assure that they will be adequately bonded.

The necessity of having "flexible" or "fluid" pressure in this kind of gluing has been previously pointed out. The rubber bag arrangement shown in Fig. 10 will provide this if a sufficiently flexible top electrode is used. A number of different electrodes, both top and bottom, were tried. The first requirement of these electrodes is that they be quite smooth and entirely free from irregularities, particularly small protuberances. Since the spacing between electrodes is only $\frac{1}{8}$ in., the slightest roughness will result in flashover.

Attempts to form copper screen or copper sheet over the mandrel as a bottom electrode came to grief. The final and quite satisfactory solution was to "metallize" the mandrel by spraying a layer of aluminum on it with a spray gun. A thick layer—nearly $\frac{1}{8}$ in. deep—was put on carefully, after which it was sanded to a mirror-like finish. This worked admirably and is, no doubt, the best answer for the bottom electrode. The top electrode is a tougher problem, since it must be free to flex. The best of those tried in these tests was a sheet of $\frac{1}{32}$-in. lead which was preformed to the shape of the mandrel by drawing. Because of the preforming there was no tendency for this sheet to crease or crack when pressure was applied. At the same time, it was soft enough to transmit the pressure almost equally and to preserve to some degree the "fluid" pressure provided by the inflated bag. There was some question whether there was quite enough flex in the sharpest part of the curvature and it is felt that thinner lead sheet—probably $\frac{1}{64}$-in. thick—would be better.

Figures 11, 12, 13 and 14 show, respectively, the mandrel in the box, the wrapped skin in position on the mandrel, the upper electrode in place and the rubber bag arranged ready for closing the box. After the box is closed and clamped tightly, the bag is inflated, r-f power applied to the electrodes through connections brought out the sides of the box, and the assembly left to "cook" for about 3 minutes. The "blister", removed from the box after this "cooking" cycle, is shown in Fig. 15.

With the arrangement shown here pressures of 45 to 50 lb were used. This is probably near the minimum. Larger pieces of heavier veneer would undoubtedly require more. To obtain such pressures on fairly large pieces will require retaining structures of great strength comparable, in fact, to the autoclaves now used. However, all the difficulties attendant on the use of steam or hot water, including particularly the deterioration of the rubber bags, will be eliminated. Time cycles can be greatly reduced.

The small "blister" mentioned above required 3 minutes for setting, as against something like 30 minutes in an autoclave. Bigger pieces can be done in the same short time if the necessary power can be justified. At the present time the repair of mandrels spoiled by water soakage is a big item of expense. Bags are also an expensive item, the average life at present being not more than one hundred cycles. Both these expenses would be greatly reduced; in fact, bags and mandrels should last in-

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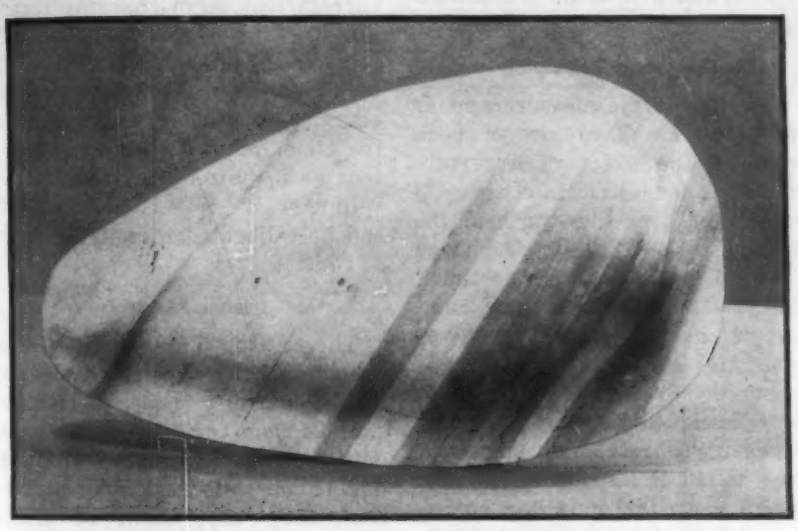

FIG. 15—Molded "blister" piece made as described in the text and "cured" by use of r-f heating in 3 minutes as compared to 30 minutes by "autoclave" method

Electronic Timer for MICROSECOND INTERVALS

A capacitor is charged for the exact duration of the interval, and the capacitor voltage then measured with a vtvm calibrated to read from 0 to 140 microseconds with an accuracy better than ±2 microseconds. Uses include measuring propagation velocities, reaction rates, time lags of relays, and projectile velocities. Calibrating methods are given

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WHENEVER a velocity is to be measured, as in acoustic or ballistic studies—whenever a mechanical, electrical, or chemical reaction time is to be determined, as in studying explosives or measuring the time-lags to be found in a multitude of electronic circuits—an instrument which measures the length of the time interval between two events may be the ideal measuring device.

Like many other devices for the measurement of some specific physical quantity, such instruments have been in existence in the laboratory for some time past. However, it often takes an additional step of consideration and design to make a rugged engineering instrument, constructable of commercially available parts, out of such a laboratory set-up.

Just such a step was required in the case of the time-interval meter to be described. It is designed to measure time intervals in the region of 0 to 140 microseconds, with an accuracy of ±2 microseconds or better. It can be built with a longer time-scale reading up to several milliseconds, if desired, and with some precautions even shorter times can be measured.

Operating Principles

Circuits for the measurement of time intervals have always been based on the effect of a certain amount of electrical charge Q transported over the length of the time interval. Either this charge Q is used to produce a proportional deflection on a ballistic galvanometer, or charge a capacitance C to a potential $V = Q/C$, which then is measured. Such instruments have been described[1,2,3,4] for full-scale ranges of a fraction of a second down to 10 milliseconds. In the present case, the capacitor charging method has been adopted, which eliminates the use of a sensitive galvanometer.

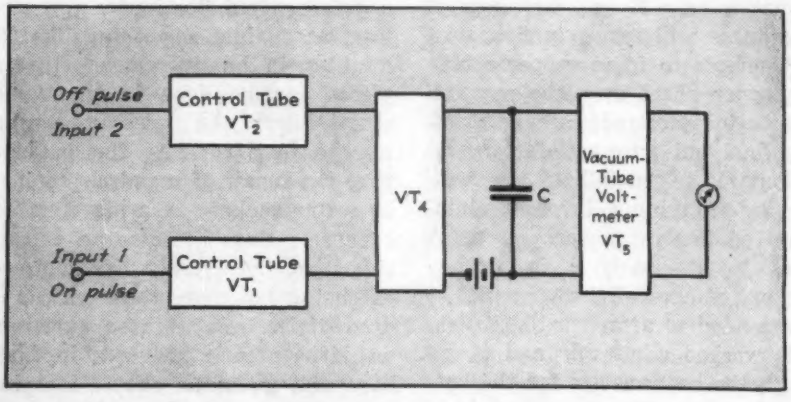


FIG. 1—Block diagram of timing circuit

The block diagram in Fig. 1 illustrates the operating principles. The two electrical impulses representing the beginning and the end of the time interval to be measured are each fed to a control tube. When control tube VT_1 receives the on pulse, it causes tube VT_4 to pass current and begin charging capacitor C. When control tube VT_2 receives the off pulse, it causes VT_4 to block. Thus, capacitor C is charged to a value depending on the time interval over which current passes into it. A vacuum-tube voltmeter reads this voltage, and can be calibrated directly in units of time.

Design Problems

There are three basic design problems which accompany the use of the charging capacitor method:

1. Leakage of charge from or onto the capacitor before, after, or during operation of the current-controlling tube must be eliminated. This imposes requirements on the leakage resistance of the charging capacitor and the general insulation used in construction, on the output impedance of the current-controlling tube, and on the input impedance of the vacuum-tube voltmeter tube.

2. In attempting to design a suitable switching circuit, it is found that most circuit arrangements which suggest themselves have the undesirable feature that various cathodes have different potentials with respect to ground, as in direct-coupled d-c amplifiers.

3. When extending the range of measurements down to time intervals as small as is the case here,

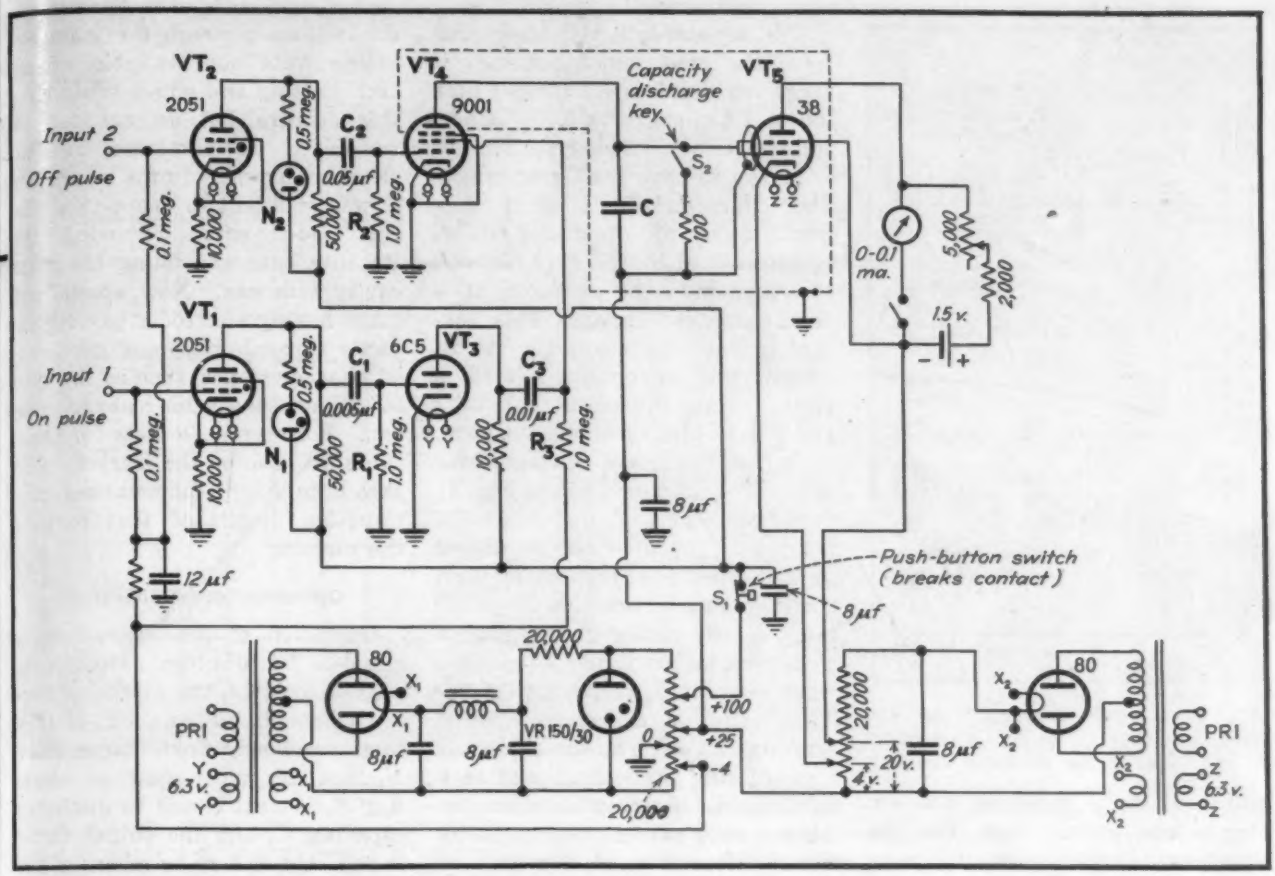


FIG. 2—Complete circuit diagram of high-speed electronic timer

care must be taken that the switching mechanism does not introduce time lags. This eliminates all circuit designs in which the two input circuits have time constants which are large compared to the time intervals to be measured.

Circuit Design

Considering all these points, the circuit design shown in Fig. 2 was finally selected. The control tubes are type 2051 gas tetrodes. There is no appreciable delay in the firing action of such tubes, as the ionization time is less than one microsecond.

In principle, when the type 9001 current-controlling tube (VT_4) is at rest it has zero control-grid voltage and negative screen-grid voltage (with respect to cathode), resulting in zero plate current. The on pulse is responsible for immediate application of a positive voltage pulse to the screen grid of this tube, causing it to pass plate current. This positive pulse is made to last for a time longer than the time interval to be measured.

The off pulse, arriving while the screen grid of VT_4 is still positive, causes immediate application of a negative pulse to the control grid of this tube, thus cutting off its plate current. The negative voltage pulse on the control grid will last a longer time than the positive screen-grid voltage swing, so that the control grid of VT_4 does not return to zero bias until the screen grid has first returned to its at-rest negative potential. Plate current therefore stays at zero after an off pulse.

The entire action, including the resulting plate-current pulse, is shown in Fig. 3, which constitutes oscillograms of the various potential and plate current variations.

The on and off pulses must be of positive polarity at the input with respect to ground. They may be capacitively coupled to the input, or direct coupled if more convenient and not disturbing to the d-c grid voltages on the input tube. Gas tetrodes are preferable to gas triodes, in order to have a minimum of capacitive coupling from grid to plate and to avoid errors due to surges or pulses following the phenomenon to be measured. An input pulse fires its gas tube, which transmits a negative voltage pulse through capacitive coupling to the following tube. The gas tubes remain conducting once they have been fired, until their plate voltage is removed momentarily by operating a push-button switch. Neon bulbs N_1 and N_2 glow to indicate that the associated gas tubes have been fired.

The polarity of the negative pulse from VT_1 (produced by the on pulse) is reversed by VT_3, thus producing a positive pulse that is applied to the screen grid of VT_4. The duration of this positive pulse depends on the time constant of R_1C_1 or R_3C_3 whichever is smaller. Here R_1C_1 governs, and the pulse stays positive for a duration of approximately 0.005 sec. If no other pulse arrived, VT_4 would stay conducting for this interval. However, the negative pulse produced by VT_3 upon arrival of the off pulse is applied to the grid of VT_4 and immediately cuts off its plate current. This pulse on the grid will decay with a time constant deter-

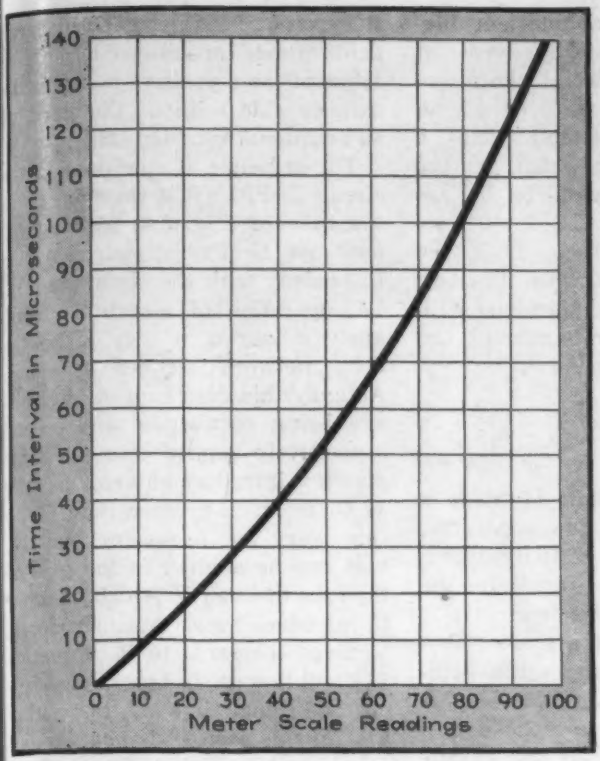


FIG. 5—Calibration curve for the electronic timing circuit

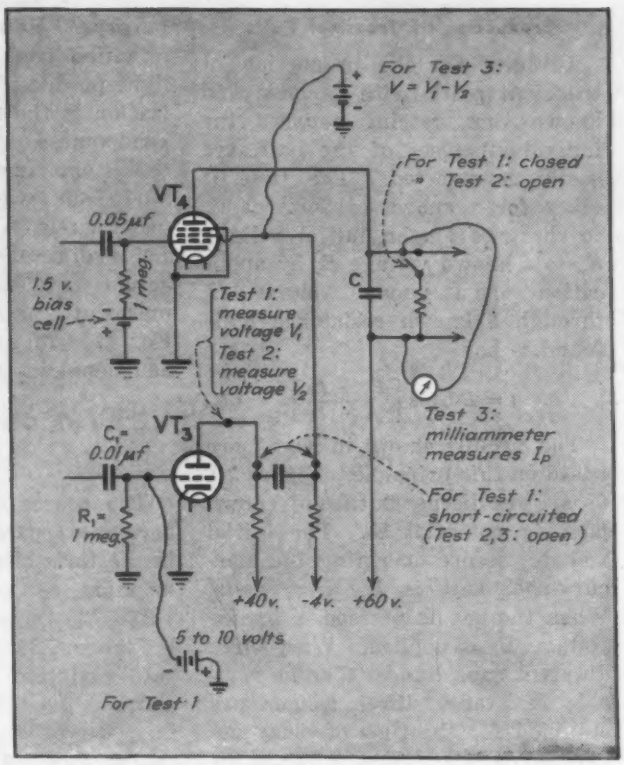


FIG. 6 (at right)—Circuit giving a capacitor charging current that is independent of the plate voltage of the charging tube. The three tests outlined on this diagram constitute a simple method of measuring the capacitor charging current and thereby calibrating the instrument. Tests 1 and 2 determine two voltage values, V_1 and V_2, whose difference constitutes the actual voltage on the screen grid during operation. In test 3 this difference voltage is applied artificially and the resultant charging current is measured. From this value the corresponding time value can be computed

ranged as in Fig. 4, so that no additional dielectric problem is created.

To provide greater sensitivity, the output meter circuit is balanced using a 0.1-ma instrument. It is most convenient to use a dry cell as the source for the balancing potential, since the drain is only a fraction of a milliampere. Voltage drop due to aging over as long as a year or more is immaterial since balancing current can be adjusted with the 5000-ohm rheostat.

For calibration of the instrument, a source for the production of two transients (pulses) with variable and known time spacing is required. If so desired, such a calibrating circuit can be incorporated in the apparatus, to provide a permanent means of re-checking.

If a source of transient pairs is available, but the time spacing unknown, the calibration can still be made with the aid of a cathode-ray oscilloscope having a variable and known sweep frequency. The procedure is obvious if the transient pairs are periodically recurrent. If they are nonperiodic, begin with a low sweep frequency and increase it. During this process, the linear spacing of the pulses on the screen becomes greater, until the sweep frequency is reached at which the two individual pulses occur at exactly the same place on the screen during two successive sweeps; this frequency then determines their time spacing.

A typical calibration curve obtained for the circuit of Fig. 2 is shown in Fig. 5.

Alternative Calibration Procedure

A design variation which shows great promise is shown in Fig. 6. It makes full use of the pentode principle of independence of plate current I_p and plate voltage E_p when the plate voltage is well above the applied screen voltage. If this constant plate current is known for the screen-grid voltage corresponding to the maximum amplitude of the screen-grid pulse when the circuit is operated in the same way as above, the voltage to which capacitor C charges for any time interval of measurement can be found with good accuracy. If this is known, a simple calibration of the plate current meter reading and grid voltage (capacitor voltage) on the vacuum-tube voltmeter tube fixes the calibration of the instrument. Although the screen-grid pulse is a transient, the assumption of a constant screen voltage is justified, since the transient's recovery ($t = R_1C_1 = 10$ milliseconds) is very large compared to the duration of the measurement (0 to 0.15 millisecond).

In Fig. 6 is shown the procedure for finding the effective maximum amplitude of the screen-grid pulse V from two tests, and subsequently finding the constant plate current I_p when voltage V is actually applied to the screen grid in the form of a battery (test 3). With this current found, the voltage to which the capacitor charges as a result of a measured pulse interval t is $E_c = T_p t/C$, where values are in volts, amperes, seconds and farads respectively. By calibrating the output meter reading in terms of a variable applied and known voltage on the grid of the vacuum-tube voltmeter, the calibration giving output meter reading in terms of time t is directly obtained.

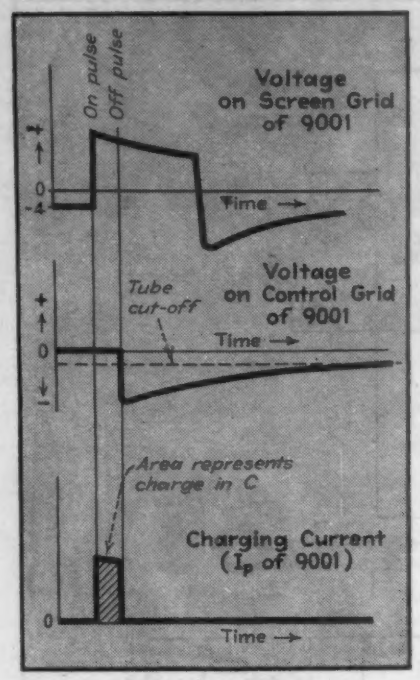


FIG. 3—Capacitor charging-current and electrode voltage curves for the type 9001 tube used in the electronic timer

mined by R_2C_2, which is 0.05 sec (ten times longer than for the screen-grid pulse). In this way VT_4 cannot conduct current at any time after the event to be measured has occurred.

Leakage Resistance Problems

Capacitor C in Fig. 2 is charged by the plate current of VT_4 during the pulse interval. The leakage problem arises here. Conditions can be considered practical and stable if, over a period of $t = 5$ seconds, there is no more than 2 percent change of voltage across capacitor C. The minimum allowable leakage shunt resistance R_s in ohms is determined as follows:

$$\frac{1}{E}\left|\frac{dE}{dt}\right| = t/R_sC$$

$$R_s = \frac{5}{0.02}\left|\frac{1}{C}\right| = 250/C$$

According to this formula, a 1-μf capacitor should have a leakage resistance above 250 megohms; a 0.1-μf capacitor should be above 2500 megohms, and so forth. Such capacitors are now obtainable. For capacitances larger than 0.1-μf, Cornell-Dubilier Dykanol capacitors were used successfully, and below this size their type 86 mica units were likewise satisfactory. The calculated leakage resistance of course combines the leakage in all other parts of the circuit.

The vacuum-tube voltmeter must have an input impedance that is large compared to R_s (larger than 2.5×10^9 ohms for a 0.1-μf charging capacitor). The type 38 tube is known to have good grid impedance characteristics if used properly. Since the input impedance is determined by the grid current, the tube must be operated at a small cathode current. This current is about 0.4 ma in the circuit shown, and is obtained with a plate voltage of about 20 volts and a grid bias of about −4 volts.

To avoid surface leakage over the bulb of the tube (VT_3 in Fig. 2) under conditions of high humidity, the top of the tube can be dipped in a molten nonhygroscopic wax. Another good precaution is painting the rest of the glass envelope with colloidal graphite (Aquadag); when connected electrically to the "cold" end of capacitor C, this serves as an electrostatic shield, as a guard ring for leakage and as a light shield. (Illumination often produces a grid current due to photoelectric liberation of electrons on the grid electrode.)

Leakage from the plate lead of VT_4 is also important. This was formerly a major problem from the point of view of using commercially available material, since ordinary receiving tubes with plate connections through the glass envelope were not available. Some transmitting and power tubes have this feature but do not cut off sufficiently to eliminate internal electron current. In the laboratory it was sufficient to use a tube like the 1B4-P after removing the Bakelite base and filling the glass cavity with wax. Now, special uhf tubes having electrodes passing directly through glass and good cut-off characteristics, such as the type 9001, have solved this leakage problem. Polystyrene sockets for these tubes are also on the market. The sketch in Fig. 4 summarizes construction details of that part of the circuit.

Operation and Calibration

Operation of the instrument is simple. Push-button switch S_1 is pushed to break the discharge current through VT_1 and VT_3 if they were previously fired. Neon bulbs N_1 and N_2 must now be dark. Key S_2 is next closed to discharge capacitor C, and the output meter is adjusted to zero by means of the rheostat. The apparatus is now ready for the measurement. After the on and off pulses arrive, the meter is read.

Before each measurement, capacitor C must be fully discharged. This is accomplished by a key ar-

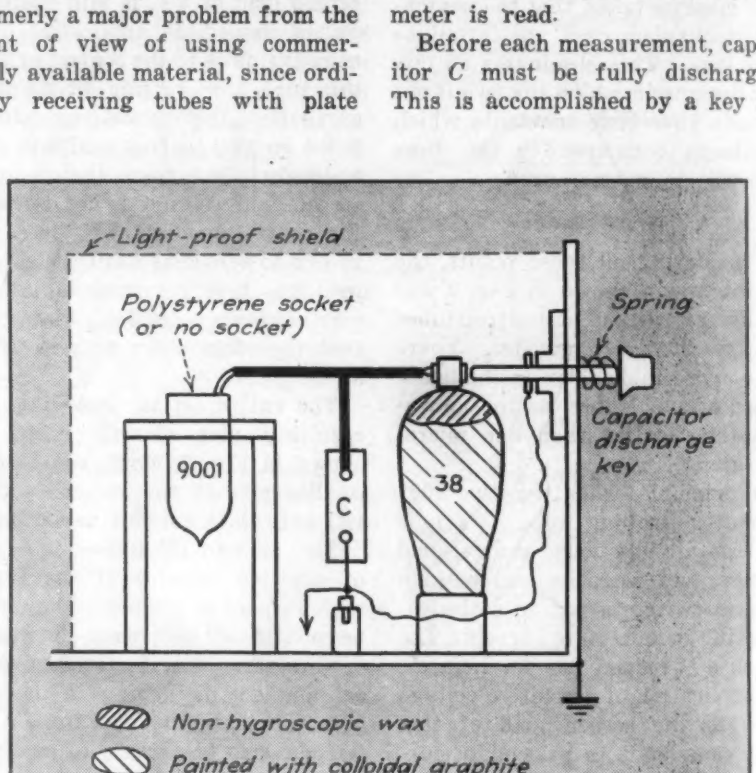
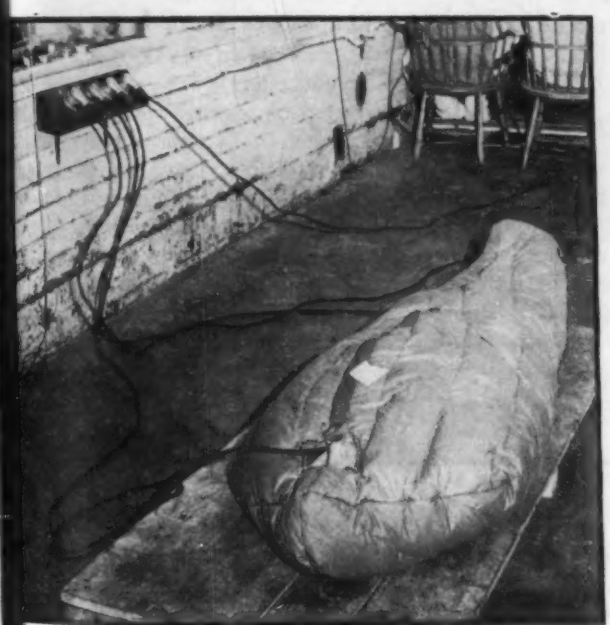


FIG. 4—Mechanical arrangement used in the vacuum-tube voltmeter circuit to eliminate leakage and photoelectric effects

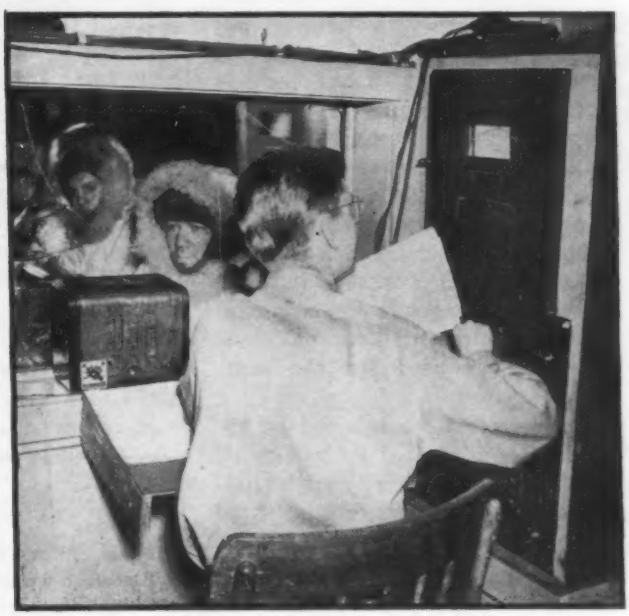
COLD TESTS

Tests of clothing at 60 deg below zero are made by the U. S. Army Quartermaster Corps, using thermocouples placed at the heart, kidney, back, abdomen, thighs and big toes of soldier volunteers

A harness holds thermocouple junctions in contact with the flesh at eight points on the soldier's body. A cable connects the couples to an electronic potentiometer which records body temperatures during various activities in arctic dress



Not a mummy, but a soldier in a sleeping bag undergoing a temperature test at 60 deg below zero to determine the reaction of the body to extreme cold while relaxed. Such tests, conducted by the U. S. Army QMC, should have an effect upon commodity standards after the war



Use of this electronic potentiometer, a product of Brown Instrument Co., has speeded up the recording of the temperature readings over a manually-operated instrument formerly used. A complete record of the eight readings for each man now requires about 30 seconds

Production of Transient Pairs

Circuits for the production of transient pairs, with variable and known time spacing between the individual pulses of the pair, are easily constructed. The time it takes for a known capacitance C, to charge from an initial voltage E_0 to a known voltage E_2 by application of a known voltage E_1 through a known resistance R is found to be

$$t = RC_0 \log \left[\frac{E_0 - E_1}{E_2 - E_1} \right] \qquad (1)$$

The circuits shown in Fig. 7 are based on this principle. Figure 7A uses a gas discharge tube of known flashing potential E_2. The initial voltage, before operating the mercury-pool key, is $E_0 = 0$ volts. When the key is pressed, a known voltage E_1 is applied. With three different capacitances C and a variable resistance, three ranges are obtained for the time of delay between pulse 1 and pulse 2, the latter of which will occur as a result of the delayed ignition of the discharge tube.

The voltage regulator tube VR105/30 can be used as a discharge tube. Its flashing potential is accurately reproducible, and was found to be $E_2 = 138$ volts $\pm$ 1 percent for four different tubes tried. Such cold-cathode gas discharge tubes introduce an intrinsic time lag which has to be taken into account. Under normal conditions, this time lag would, in fact, be random and unpredictable, rendering the tubes worthless for this purpose. However, sufficient illumination from a steady source of light produces sufficient photo ionization in the tube to eliminate all randomness, and simply yields a consistent time lag which, for the VR105/30, was found to be approximately $t_s = 2.5 \times 10^{-5}$ sec for 4 different tubes. Thus, the actual time lag between the two pulses of a pair is determined with Eq. (1), taking into account the additional intrinsic lag t_s:

$$t_{real} = t + t_s = RC_0 \log \left[\frac{E_0 - E_1}{E_2 - E_1} \right] + 2.5 \times 10^{-5} \text{ sec.}$$

The source of light is made a permanent part of the apparatus, in the form of a 25-watt light bulb mounted so as to irradiate the VR105/30 through its top.

Figure 7B shows a more elaborate variation of the same principle. A gas-tetrode (2051) is used in place of the cold-cathode discharge tube. This has two advantages: (1) The intrinsic lag of the gas tetrode (or triode) is negligible; (2) The inter-electrode capacitance (grid to plate) is very small. The arrangement in Fig. 7B is of great advantage for very short time intervals, since there would otherwise be danger of inducing a non-delayed pulse in the output circuit of pulse 2 by way of capacitive coupling. To make full use of this feature, the delayed pulse must be taken from the plate circuit, and since this pulse has negative polarity, must be reversed in phase by a subsequent vacuum tube. If it were not for the relatively large grid-cathode capacitance it could be taken off as a positive pulse on the cathode side without the need of an additional inverter stage.

The principle of operation of the circuit in Fig. 7B is the same as in the case of Fig. 7A, although it may not be immediately obvious. In analogy with the circuit in Fig. 7A, operation of switch S should apply a known voltage E_1 to the delay network between a and b. Actually this does happen, the voltage being between a' and b' and capacitively applied over C_L. This does not introduce an error as long as C_L is much greater than C. In this way, the necessary negative bias can be applied to the grid of the tube through R_c which, in order to introduce no error, must merely be large compared to R. Equation (1) will now apply accurately without additional time lag, but noting that in this case E_0 is not zero but equal to the permanent negative bias (—45 volts). The voltage sources were drawn as batteries merely for the sake of simplicity; a-c operation is naturally possible, and can be carried out in the customary ways.

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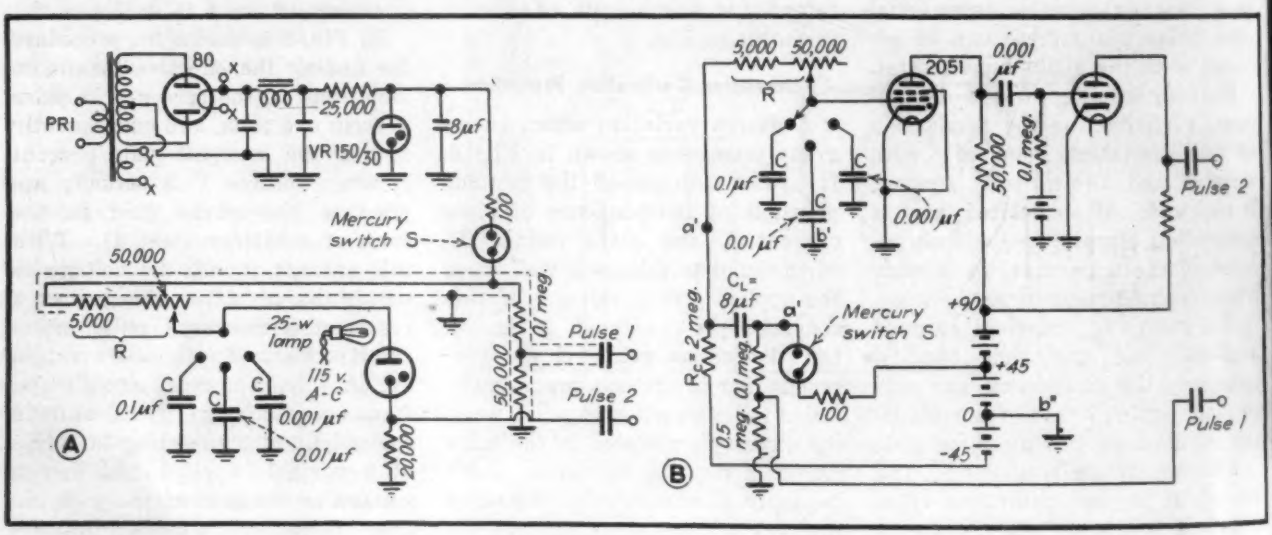

FIG. 7—Two circuits for generating a pair of pulses having a given and known time spacing, for use in calibrating the electronic timer

Photoelectric INDUSTRIAL

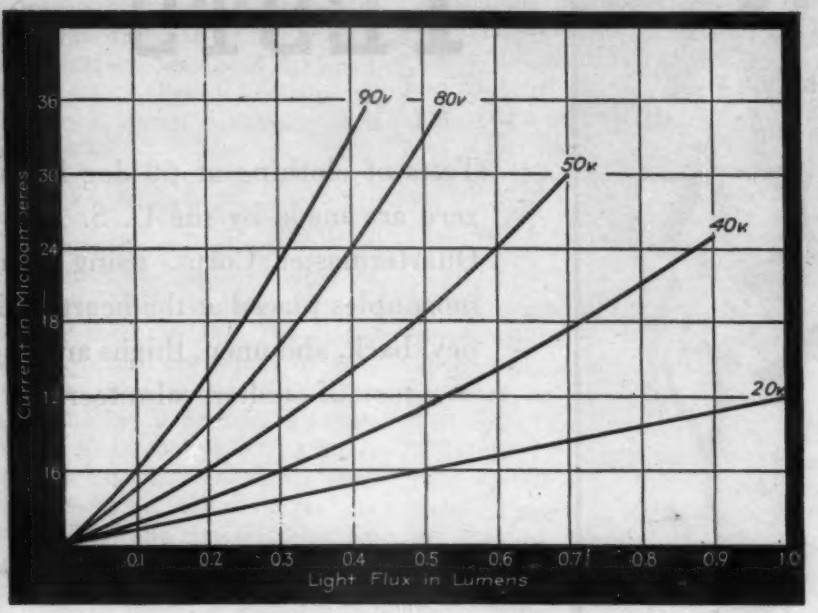

Fig. 1—Current-illumination characteristics of typical phototube

MANY industrial engineers and plant superintendents have been afraid of photoelectric equipment and have regarded it as delicate gear that must be carefully handled. This is, today, an erroneous idea. Photoelectric equipment is now constructed to meet the same rigid requirements as other well-constructed industrial control equipment.

The art of manufacturing electronic tubes has progressed to such a point that they are sturdy and long-lived. Similarly, maintenance of photoelectric equipment presents no greater problem than that of other industrial controls. In many cases, maintenance is less on photoelectric equipment than on other type controls used for the same purpose.

Photoelectric controls can be applied without special knowledge of electronics. Familiarity with amplifiers, control circuits and tube theory is not necessary. One must know only what the equipment will do and how it can be used.

For photoelectric control, light is used as the controlling medium rather than mechanical or electrical contacts. Operations where friction cannot be tolerated (or where mechanical contact cannot be made) are readily and conveniently controlled with simple photoelectric apparatus.

Types of Devices

In general, control by means of light is accomplished by three basic types of photoelectric devices: (1) Photoconductive cells, in which the resistance of a semi-conducting solid substance to electric-current flow is reduced by light radiation. (2) Photovoltaic cells, in which light energy produces a difference in potential across two substances that are in close contact. Sometimes the photovoltaic cell is called a barrier-layer cell. (3) Photoemissive cells, or tubes, whose action is produced by emission of electrons from a light-sensitive cathode surface.

Photoconductive and photovoltaic cells are quite rugged in construction and have relatively high current output. This sometimes makes possible the direct operation of meters, relays or other current operated devices. An amplifier can be used with any one of the three types of light-sensitive devices, however, and the photoemissive type is often selected since its output is so readily amplified.

Phototubes

Photoemissive devices called phototubes are probably the most widely used. They contain two elements, a cathode and an anode, sealed in a glass tube. The cathode is semi-cylindrical in shape and consists of some base metal (such as silver) coated with caesium oxide, which is sensitive to light. The anode generally consists of a straight wire electrode mounted along the axis of the cathode. Light falling upon the cathode results in emission of electrons from the light-sensitive surface. The released electrons are drawn to the anode by virtue of an external voltage applied between the anode and cathode.

Selection of cathode material determines the spectral response of the phototube. Pure sodium, tungsten-on-nickel, thorium-on-nickel or titanium-on-nickel cathodes are particularly sensitive to ultraviolet radiation. A thin layer of caesium deposited on a layer of caesium oxide (formed on a silver surface) is sensitive to visible and infrared

TYPICAL APPLICATIONS

Paper mill break indicator
Automatic weighing
Cellophane bag machine controls
Stopping of mechanical devices
Liquid level control
Initiation of flying shears in steel mills
Counting units on production line
Safety Control of machinery, furnaces
Concentration and color control
Weld comparers
Plant protection
Tin reflow regulators
Door opening and closing initiation

CONTROLS

Rugged construction has taken the electronic equipment out of the experimental stage and made it an important industrial tool. The principles of operation of gas and vacuum-type phototubes and the use of accessories are described

By HAROLD J. HAGUE

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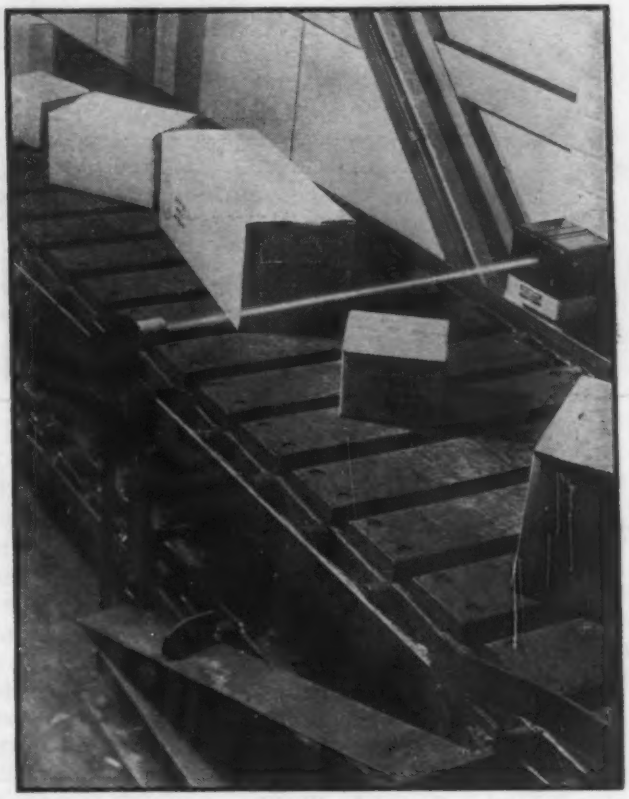
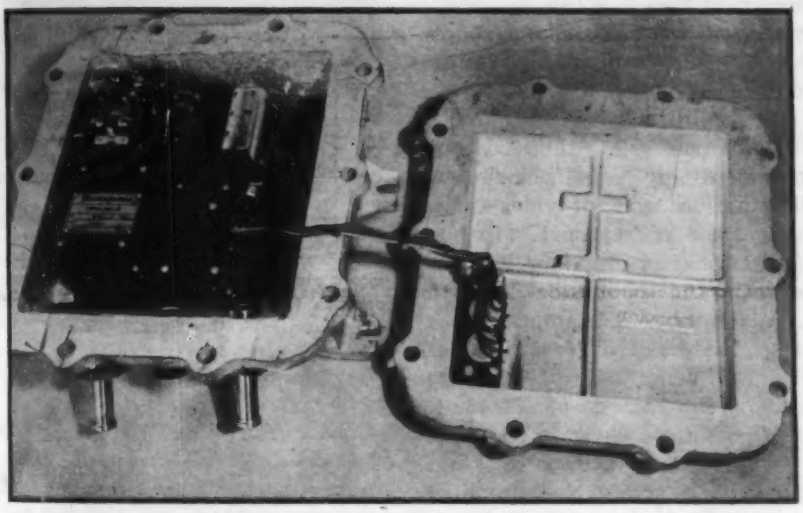


Photoelectric unit of the type commonly employed for counting boxes or packages on a conveyor



An explosion-proof case for special applications encloses this control unit

rays and is a very satisfactory type of cathode. It is particularly useful where Mazda lamps are employed as light sources.

Optical filters and phototubes may be combined to alter the color-sensitivity response of the phototube. If a green filter is used with the Westinghouse type WL-770 phototube, for example, the response is almost identical to that of the human eye.

Phototubes can be divided into two classes, namely, gas and vacuum. The two designs are identical as to structure. A high vacuum is employed in the vacuum type and an inert gas such as argon, neon or helium (at very low pressure) is used in the gas-filled type.

Gas Tubes

Gas-filled phototubes are much more sensitive than vacuum-type tubes. The greater effective response is obtained through gas amplification and secondary emission. Electrons emitted by action of light rays on the cathode are drawn to the positive anode. High velocity of the photo-emitted electrons is sufficient to knock out additional electrons from the gas atoms with which they collide. Gas atoms are thus split into positive ions and free electrons.

The free electrons are drawn to the positive anode and the positive ions migrate toward the negative cathode. The positive ions surround this element of the phototube and exert such force that additional electrons are emitted which combine with the original photoelectric current. These two factors produce additional photoelectric current that may be several times the value of primary electron current.

Phototubes are not particularly sensitive to temperature changes. However, the maximum operating temperature for most commercial phototubes should not exceed 50 deg. C (122 deg F). The temperature referred to is that which comes in contact with the bulb, or the ambient temperature. If the phototube is operated above recommended temperature, sensitivity may decrease. High operating temperature also decreases life of

Fig. 2—Inexpensive light relay for indoor applications where low sensitivity is permissible

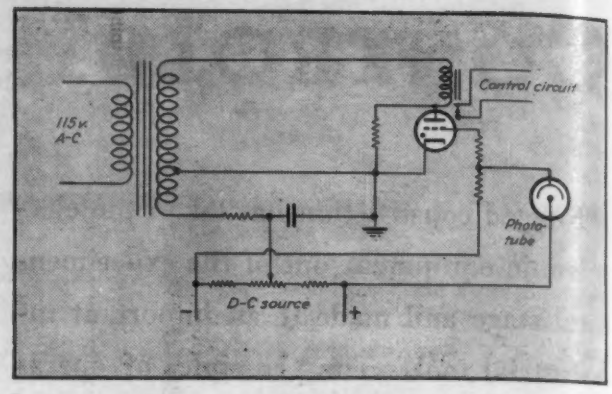


Fig. 3—Schematic circuit of a phototube and thyratron as used to form a simple photoelectric relay

the tube due to evaporation of volatile material on the cathode.

Under ideal operating conditions (normal temperature, proper voltage on the anode and sufficient light on the cathode) the output of ordinary gas or vacuum phototubes does not exceed 100 microamperes per lumen of light. The curves of Fig. 1 show how current flow in phototubes is affected by illumination intensities. It is usually necessary to amplify this small current if phototubes are to be of practical value. The device that amplifies the small currents of a phototube is called a light relay, or photoelectric relay.

Relays

Photoelectric relays are available in a number of different designs. When used to supply initiating action to open and close doors (or for operation where maximum sensitivity is not required and distance from the light source does not exceed, say, 20 feet), a light relay such as shown in Fig. 2 may be used. Such an arrangement consists of a phototube, a thyratron tube, a transformer (to supply proper filament and anode voltages) and miscellaneous small capacitors and resistors.

Thyratron characteristics are such that when the negative grid potential (relative to cathode) exceeds the critical breakdown voltage (for corresponding anode voltage), the tube does not become ionized and no current is conducted through the tube. When the grid potential becomes more positive than the critical grid voltage, the tube breaks down and conducts current. In the photoelectric relay shown in Fig. 2, a negative voltage (relative to cathode) is applied to the grid of the thyratron tube. When the phototube is illuminated, this negative thyratron potential is balanced out as a result of current flow through the phototube and the thyratron conducts current.

As shown in the diagram of Fig. 3, the coil of a relay is connected in series with the anode of the thyratron tube. When the coil is energized, the relay contacts operate a counter or other suitable control.

Many installations require a photoelectric relay that responds to exceedingly small changes in illumination and provides maximum speed of response. In such applications, an amplifier is placed between the phototube and the thyratron tube. The amplifier magnifies the small current impulses that are generated by action of light on the cathode of the phototube. Figure 4 shows a photoelectric relay that utilizes a single stage resistance-coupled amplifier. The phototube is on the left, the amplifier tube is in the center and the thyratron is on the extreme right.

Register Control

Photoelectric relays designed for maximum sensitivity and speed of response are used in installations where the distance between light source and phototube is about forty feet or more. Many are also used for register regulator applications. Register regulators are found in many industries where consumer products (such as cigarettes and candy bars) are wrapped automatically by machine. Such regulators control the cutting of rolls of paper. Aligned to plus or minus $\frac{1}{32}$-in. accuracy, they control the cutting along one edge of the roll. This edge control assures cutting the paper into sheets of the right size to conform to some definite pattern on the wrapper itself. The pattern is often made an integral part of the design of the wrapper. In other cases, the design (frequently a small rectangular spot $\frac{1}{4}$x$\frac{3}{8}$ in.) is placed on one edge of the paperstrip. Register regulators have made paper speeds up to 3,000 ft per minute possible.

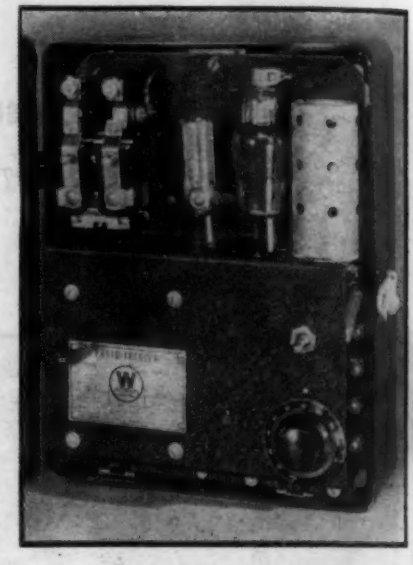


Fig. 4—In this unit the phototube feeds into a single-stage amplifier which, in turn, controls the thyratron under the shield at the right

When light source and phototube are over 40-feet or so apart it is difficult to obtain sufficient illumination on the phototube to operate the photoelectric relay. In

such cases, it is rarely practical to increase the sensitivity of the photoelectric relay since extraneous light (such as that reflected from light-colored objects, windows and people's clothing) is apt to cause false operations. Filters used to provide an invisible light beam sometimes help and sometimes merely accentuate the difficulties. A phototube housing having infrared filters is shown in Fig. 5.

Interrupted Beam

A photoelectric relay, responsive only to a rapidly pulsating light, has been designed for applications where distance between light source and phototube is between 40 and 225 feet. Constant illumination has no effect on the unit, thus, false operation cannot result from light reflections. Pulsating light is obtained by interrupting the light beam with a motor-driven slotted disc that produces five hundred and forty interruptions per second. Figure 6 shows a light source suitable for outdoor pulsating-light installations.

The phototube is not always located near the photoelectric relay. In some applications, space limitations or appearance make it desirable to place the photoelectric relay and the phototube forming part of this unit in different places. The phototube can be mounted in a separate housing and can be connected to the relay by means of a cable. Any convenient position and location (where mechanical vibration is not excessive) can be chosen for the housing so long as it can be rigidly mounted to insure constant alignment with the light beam. Under normal conditions, the cable connecting phototube and relay rarely exceeds ten feet. Increased capacitive reactance in longer cables will influence sensitivity of the relay.

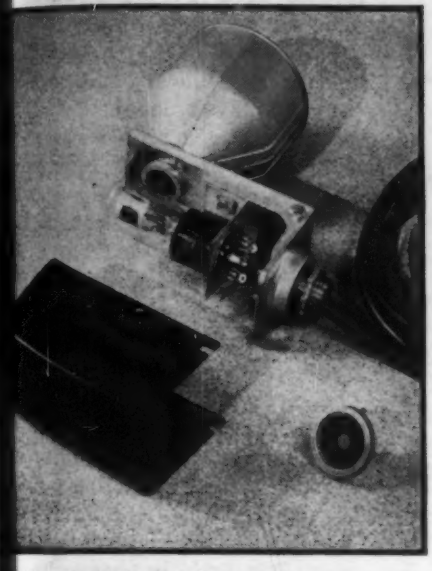
In the majority of photoelectric applications, a special light source is required for successful operation.

Light Sources

Normally, a source includes: (1) A small lamp that usually operates on a potential of six to eight volts. (2) A transformer to supply correct filament voltage to the lamp. The transformer is generally an integral part of the light source. It can also be a separate winding on the main control transformer in the photoelectric relay. (3) A lens assembly to concentrate the light beam. (4) A light-source housing, usually of cast metal and constructed to facilitate lamp inspection and mounting-position adjustment.

In some instances it is desirable to have the light source and phototube housing built as one integral part. Such a combination is called a "scanner." Figure 7 shows a scanner that is often used on register regulator applications. This scanner has a single tube amplifier circuit built in to insure maximum sensitivity and speed of response.

Photoelectric relays, phototube housings and light sources are available with different enclosures for all types of applications. They can be used indoors, in damp outdoor locations, and even in explosive atmospheres where exposed sparking contacts would be hazardous.



—This phototube housing contains a large lens and infrared filter

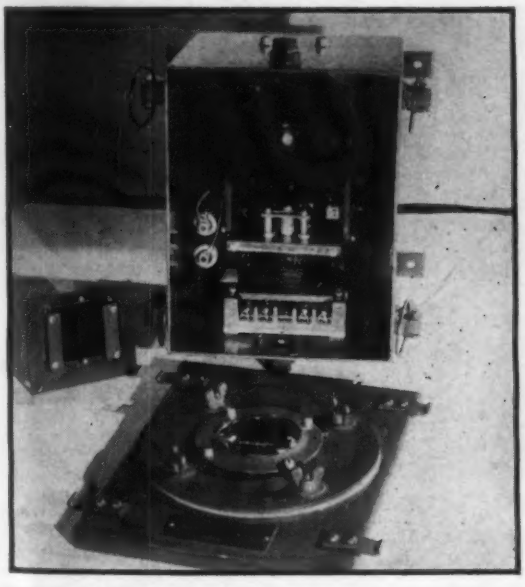


Fig. 6—False operation due to light from other sources is eliminated by the use of this motor-driven slotted disc to interrupt the light beam

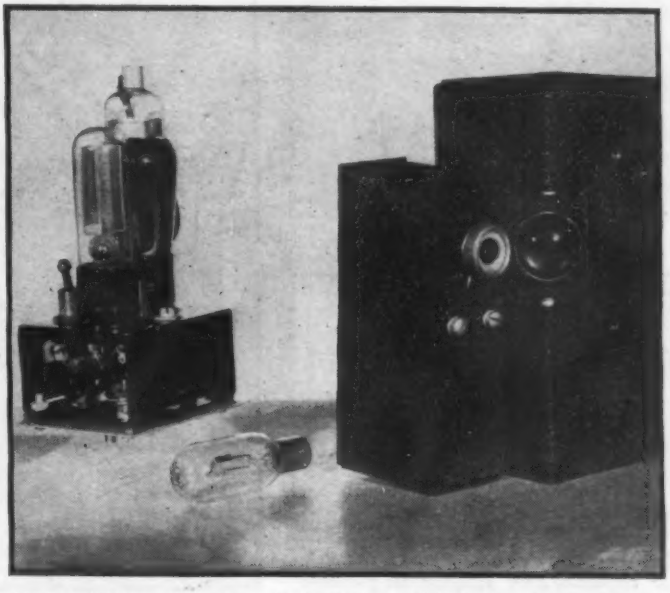


Fig. 7—This combination of phototube and light source in one unit is called a "scanner" and is useful for register-regulator applications where light is reflected from printed moving register marks

EQUALIZER DESIGN

Attenuation and phase functions of frequency-transmission characteristics in circle diagrams, for determining performance and selecting circuit constants of "constant-resistance" and other conventional types

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THE USE of circle diagrams for facilitating the solution of various problems in engineering is well known.[1, 2] A chart which may be used in determining the characteristics of a large number of electrical circuits used in audio and r-f systems is to be described.

The attenuation, phase and impedance functions of various corrective networks may be determined directly from the chart by following the circular loci of constant A and constant X. Here A is the ratio of two resistances, while X is the product of radian frequency and an inherent time constant of the circuit. As soon as particular values of A and X are determined from given specifications, the behavior for all other values of X or A is read directly from the chart. Examples showing both methods of application will be considered.

Suppose it is desired to design a simple low-pass network satisfying the following specifications:

(1) As the frequency increases, the attenuation introduced by the network is to increase gradually from zero to not more than 14 db, while at the pivoting or "cross-over" frequency of 1000 cps, the attenuation should be 7 db.

(2) The network is to work from a signal source having 500 ohms internal resistance.

A circuit having these general characteristics is shown in Fig. 1a, and in the fourth-quadrant group of circuits shown on the chart. The problem is to determine the values of the resistances R and AR, and the capacitance C, which satisfy the specifications. Since the source internal-resistance is to be 500 ohms, it is possible to let R be this internal resistance, 500 ohms. For purposes of analysis, let the signal-source voltage be a sine wave of frequency f, represented by the complex quantity E_o. Let the output voltage be another complex quantity E which differs from E_o in both magnitude and phase.

Certain facts are evident on inspection of Fig. 1a. For d.c., or zero frequency, the ratio $E/E_o = 1$, or E and E_o are equal both in magnitude and phase. As the frequency increases and approaches infinity, the reactance of the capacitance C and the voltage across C approach zero together. Hence, at infinite frequency, E is again in phase with

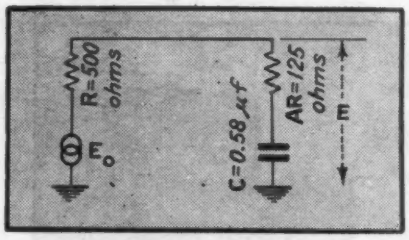


FIG. 1a—Equalizer of Example 1

f (cps)	X	Atten. (db)	Phase Shift
295	0.53	1.5	−27°
520	0.94	3.5	−37°
1,000	1.8	7.0	−42°
1,950	3.5	10.5	−36°
3,900	7.0	12.5	−25°

FIG. 1c—Table of computed values of X for corresponding selected frequencies f, and readings of values for the attenuation and phase-shift functions taken from the chart

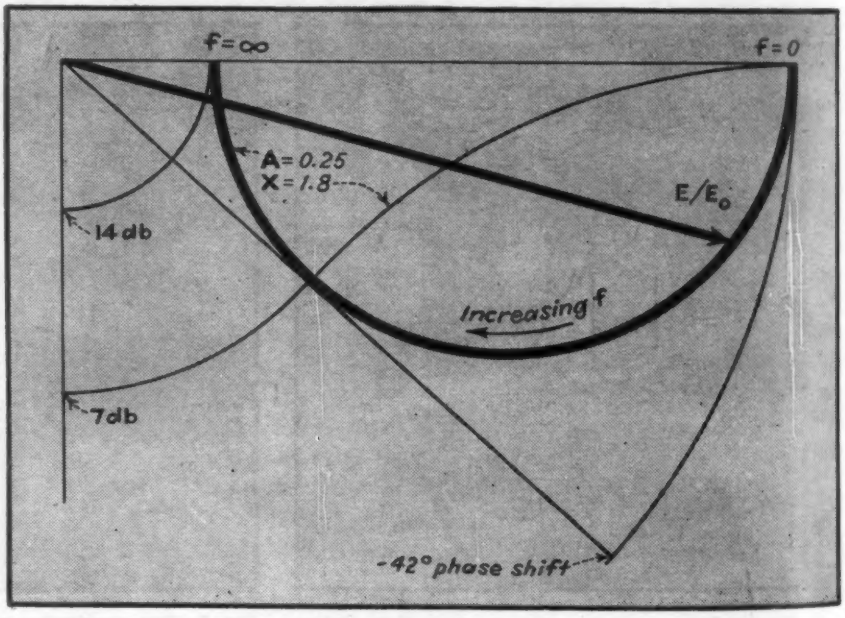
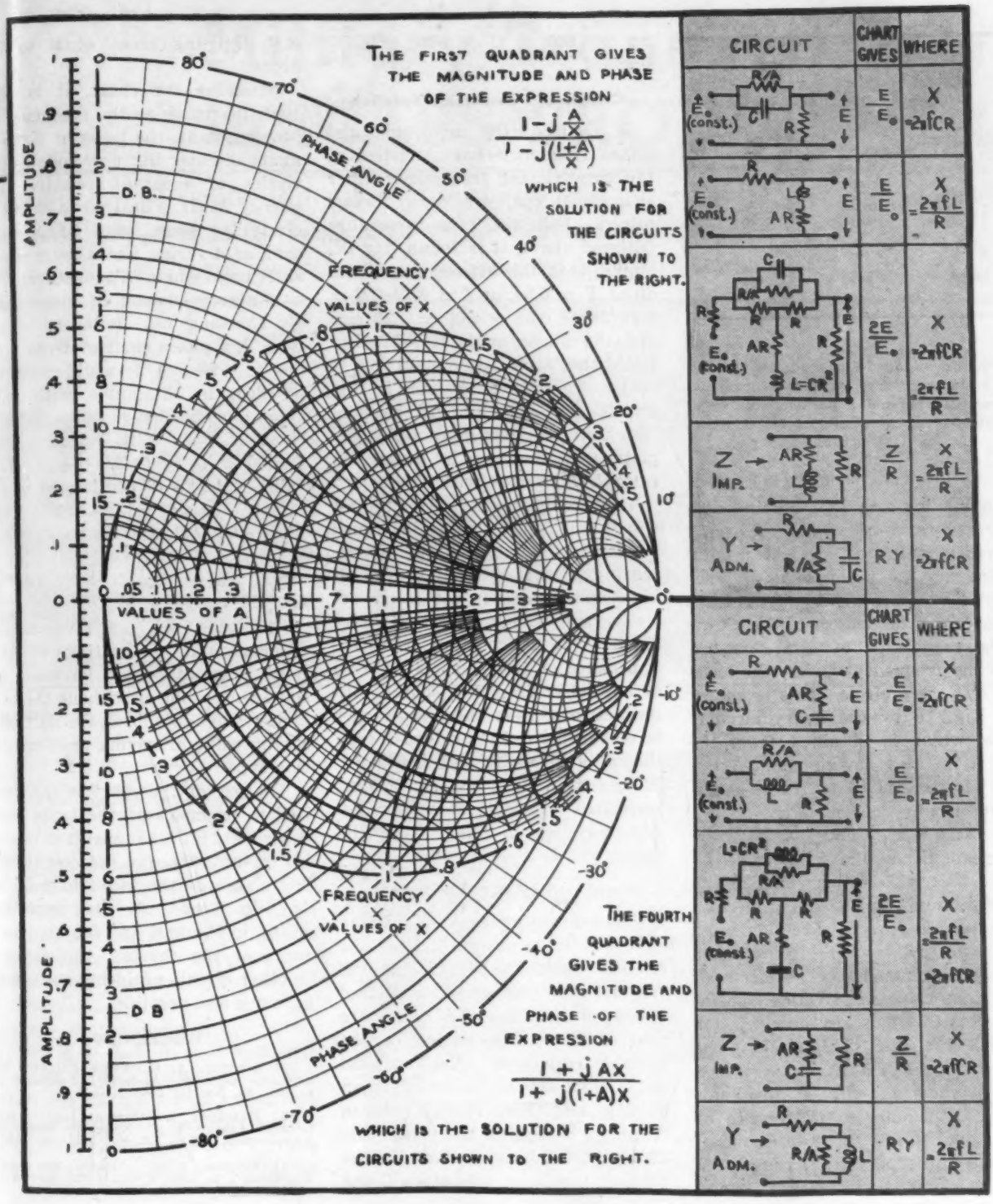


FIG. 1b—Simplified, partial duplication of the design chart, for use in solution of the network of Fig. 1a



E and should be 14 db below E_o, or $E/E_o = 0.2$. But $E/E_o = AR/(R + AR) = A/(1 + A) = 0.2$, or $A = 0.25$. This determines AR to be equal to $0.25 \times 500 = 125$ ohms. For intermediate frequencies, a little consideration will show that the voltage E lags E_o and has a magnitude somewhere in the range between $E = E_o$ and $E = 0.2\ E_o$.

Consider now the use of the chart in determining quantitatively the manner in which the ratio E/E_o varies with frequency. Reference is first made to Fig. 1b, since it is a simplified but partial duplication of the portions of the circular loci chart which pertain to the problem.

The end of the heavy arrow indicates the complex quantity E/E_o. The magnitude of this ratio is equal to the length of the arrow, while a clockwise or counter-clockwise arrow rotation indicates a respective phase-angle lag or lead of E relative to E_o. As the frequency increases from zero to infinity, this arrow starts from a horizontal position where $E/E_o = 1$, then rotates clockwise, decreasing in magnitude. The rotation indicates that E lags in phase relative to E_o. After the arrow reaches a point of −42

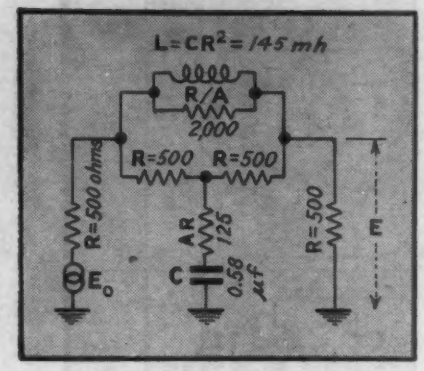


FIG. 1d—Bridged-T network derived for constant-resistance impedance-match at both its input and output terminals, with attenuation characteristics for the circuit of Fig. 1a

deg maximum lag, it continues in reverse rotation, while decreasing further in magnitude. At infinite frequency, the arrow is again horizontal, where E and E_0 are again in phase, and the length of the arrow (the magnitude of E/E_0) is 0.2. As the frequency varies, the locus of E/E_0 is a circle. This is shown in Fig. 1b by the heavy circular line, which is obtained from the chart in the following manner:

It is recalled that a 14 db maximum attenuation is desired at infinite frequency. Thus, on the vertical-amplitude, linear, db scale, locate the circle of constant 14 db attenuation. Follow this circle in a counter-clockwise direction and note the point where it intersects the horizontal line. The circle of constant value of A which also intersects this point is the circle for which $A = 0.25$. This circle is the desired locus of E/E_0.

The chart and Fig. 1b also show that, orthogonal to the circles of constant A, are those of constant relative frequency X. As indicated in the fourth quadrant of the chart, $X = 2\pi fCR$, i.e., X is proportional to the frequency, and equals unity at the frequency where the magnitude of the reactance of capacitance C is equal to R. It is now recalled that, at 1000 cps, the specifications require an attenuation of 7 db. Figure 1b and the chart show that the circle of constant 7 db attenuation intersects the circle of constant $A = 0.25$ at the value of $X = 1.8$. Hence, C is determined by noting that $X = 1.8 = 2\pi fCR = 2\pi \times 1000 \times C \times 500$, or $C = 0.58$ μf.

Complete Transmission Function

If desired, the amplitude and phase frequency-characteristics of the network, for frequencies other than 1000 cps, are easily determined. Following the procedure outlined above, it is found, for example, that the attenuation is 3.5 db at $X = 0.94$, or $f = X/2\pi CR = 0.94/2\pi \times 0.58 \times 500 = 520$ cps, and the phase angle is −37 deg. Both the attenuation and phase characteristics are tabulated in Fig. 1c. It should be noticed particularly that the chart gives a physical picture of the way in which the ratio E/E_0 varies with frequency.

The circuit chosen is the simplest which will fulfill the specifications, but it has the disadvantage of presenting to the 500-ohm source an impedance which is not solely resistive and which varies with frequency. If a constant resistive impedance of 500 ohms is desired, as one looks from the source into the network, then the circuit may be elaborated to the bridged-T type shown on the chart and in Fig. 1d. This is one of a series of "constant resistance" networks[3] whose solution may be obtained using the chart.

Phase-Shifting Network Example

Suppose a simple phase-shifting circuit is to be designed using the circuit shown in Fig. 2. At the frequency of 1000 cps it is desired to control the phase of E relative to that of E_0 by the setting of the variable resistance AR. The total phase shift should not be less than 35 deg, and there should occur a minimum change in the magnitude of E as its phase is varied. The problem now is to determine C and AR, R being given equal to 500 ohms.

Studying the chart, it is seen that, inasmuch as the frequency is now constant, the locus of E/E_0 is again circular but now follows the circles of constant relative frequency X. It is desired to choose a circle for some value of X such that, as A varies, a maximum phase shift occurs in E/E_0 together with a minimum change of magnitude. By choosing the circle for which $X = 2$, a phase shift of from −65 deg to −28 deg, or a difference of 37 deg, is obtainable with only about a 0.6 db change in magnitude. Hence $X = 2 = 2\pi fCR = 2\pi \times 1000 \times 500 \times C$, or $C = 0.64$ μf. The value of A at −65 deg is zero, while at −28 deg the value of A is 0.48. Thus AR should vary from 0 to 0.48, so the resistance AR of Fig. 2 should vary from zero to $0.48 \times 500 = 240$ ohms.

The table in Fig. 2 gives values of phase shift vs. settings of AR. Some attempt should be made to solve this problem without the use of the chart to appreciate its time-saving value in solving problems of this type.

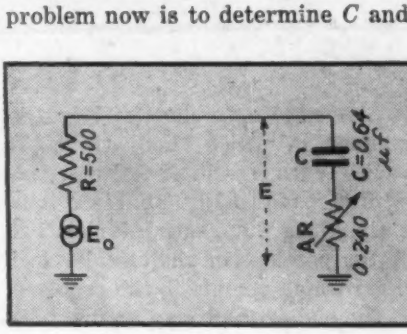
The use of the chart is not limited to examples of the types just described. For example, it is possible to solve also for the magnitude and phase of the input impedance or admittance of the networks shown in the first and fourth quadrants of the charts. Applications to other circuit problems not given here are also possible.

References

(1) Seletzky, A. C., Cross Potential of a 4-arm network. *Electrical Engineering*, p. 861, 52, No. 12, Dec. 1933.

(2) Hazeltine, A., Current Loci in the General Linear A. C. Network. *Electrical Engineering*, p. 325, 56, No. 3, March, 1937.

(3) Terman, F. E., "Radio Engineers' Handbook", p. 245, McGraw-Hill Book Co. (1943).



A	AR (Ohms)	Phase Shift
0.48	240	-28°
0.33	165	-37°
0.18	90	-46°
0.09	45	-55°
0	0	-64°

FIG. 2—Phase-shifting network, for constant-amplitude phase-correction, discussed in Example 2. Values of AR, adjusted for the desired condition, are given in the table

Military Transmitter in MASS PRODUCTION

Assembly system similar to those used in the pre-war manufacture of radio receivers is successfully applied to the fabrication of the heavier, much more complicated BC-610-E. Units pass through the steps pictured here in less than six hours

Phantom view of the SCR-299 communications truck and trailer. The transmitter seen in forward part of truck is the BC-610-E

By C. T. READ
Engineering Department
The Hallicrafters Company
Chicago, Ill.

IN THE home-front battle of war production, an outstanding victory has been won by the adaption of mass-production technique to the manufacture of heavy, yet complicated electronic equipment.

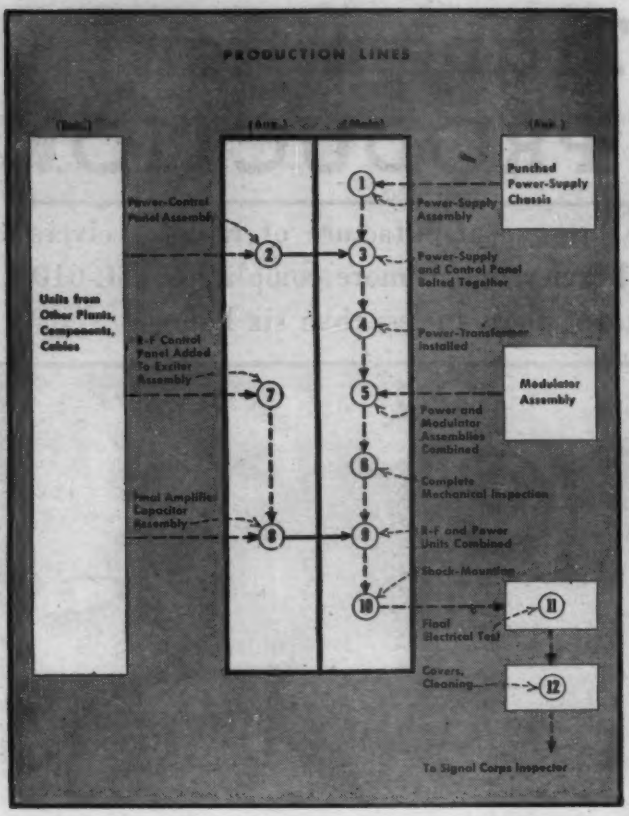
Everyone is familiar with the success that automobile manufacturers have had in applying their methods of fabrication to the airplane engine. Less well known has been the successful use of mass production methods in the construction of radio transmitters.

Apparatus which in pre-war days was virtually custom-built by skilled craftsmen is now being produced on the assembly line. Not only has production been speeded up, but quality has been improved.

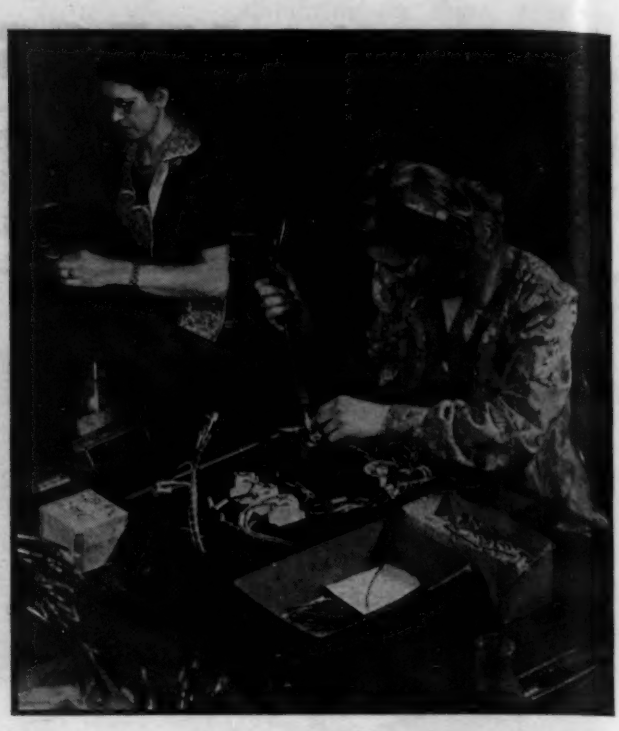
The accompanying pictures, taken in the Clearing, Illinois plant of the Hallicrafters Company, where the pre-war model HT-4 transmitter is now being built in large quantities for the armed forces as the BC-610-E, illustrates the major steps in assembly.

1 **Power-supply assembly starts here, on the main production line. This chassis forms a base for the entire BC-610-E transmitter. Rectifier tube sockets, filter chokes and capacitors are the first component parts to be installed. A special wood table holds the chassis upside down for this step**

Military Transmitter in



General floor plan showing the production-line scheme employed. Units assembled elsewhere, and components, are delivered to the sub-assembly lines shown at the left and right. Work progresses from the top of the diagram to the bottom, with direct physical transfer from auxiliary to main line facilitated by the adjacent position of these two lines



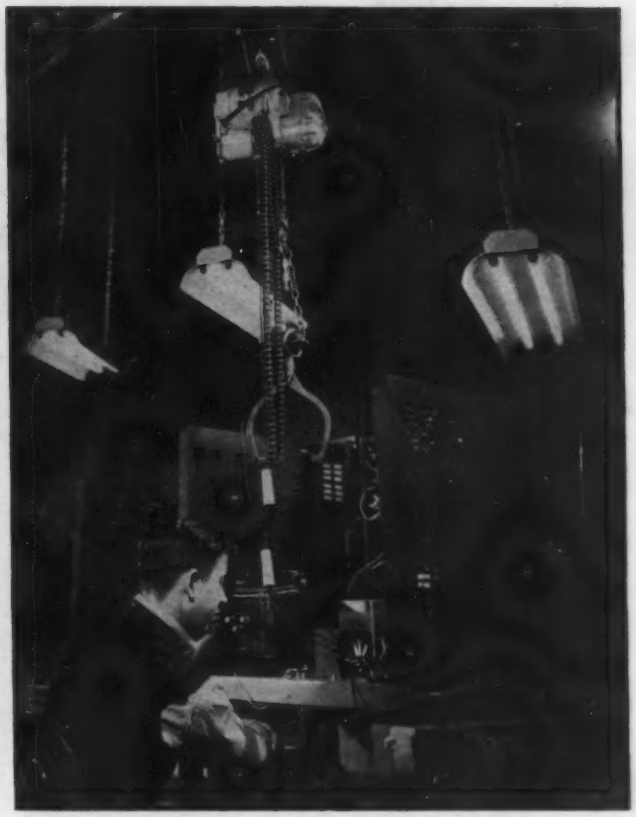
2 Power-control panel assembly starts here, on an auxiliary production line. Parts are mounted on the panel and wiring is completed

5 The power-supply section of the BC-610-E transmitter is picked up by means of an electric hoist and placed on a dolly which can be moved by hand the rest of the way down the assembly line. This photo shows the modulator chassis, received from a sub-assembly line, being lowered into place. Inter-connection cables are installed here

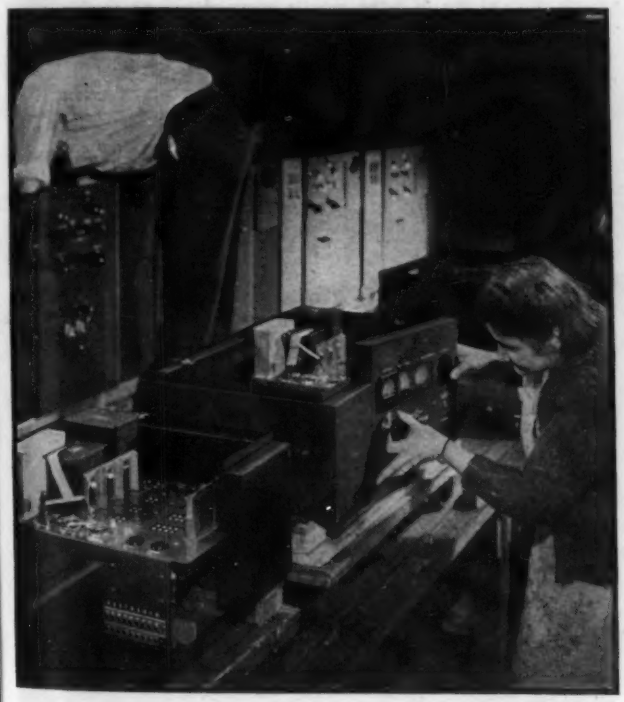
6 The power-supply and modulator unit receives a complete mechanical inspection. All main support bolts are tested with a special torque-measuring wrench. The bolts holding the main power transformer, for example, must not turn until a torque of 90 inch-pounds is applied

Mass Production (Continued from p. 121)

3 Shifted to the main production line, the assembled and wired power-control panel is bolted to two side members and forms the front of the cabinet. The power-supply chassis is lifted and lowered into place, forming the bottom



4 After the power-supply chassis and power-control panel are fastened together, the unit is turned over and placed in a jig. Then the main power transformer, weighing 113 lb., is lowered into position and bolted down



7 Back on the auxiliary production line, an exciter chassis built as a complete unit at another Hallicrafters' plant is installed in the r-f section of the cabinet and a control panel containing meters, band-switch and final amplifier tuning control is placed in position

8 The final amplifier tuning capacitor assembly and a socket for the final amplifier tube are installed, and r-f wiring is completed

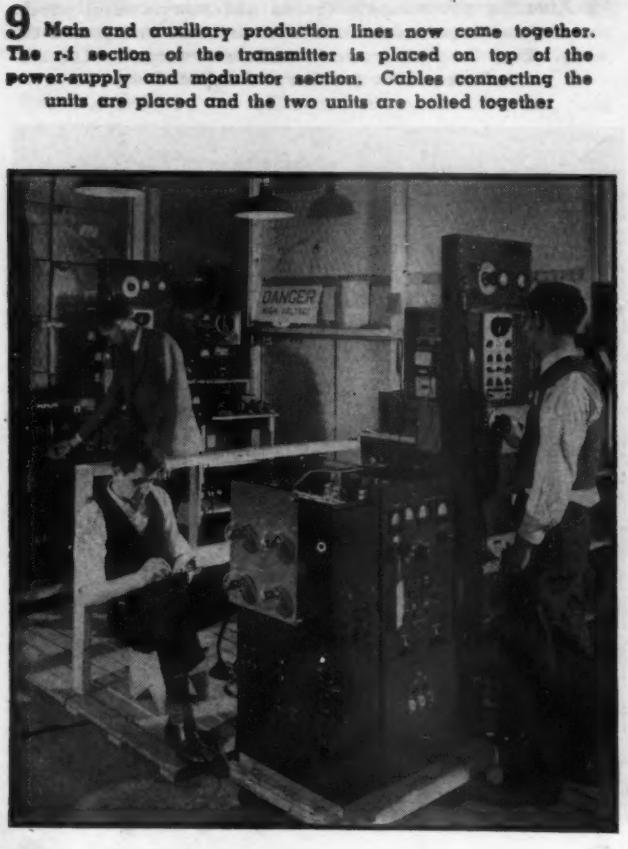
➤

Military Transmitter in Mass Production

(Continued from page 123)

9 Main and auxiliary production lines now come together. The r-f section of the transmitter is placed on top of the power-supply and modulator section. Cables connecting the units are placed and the two units are bolted together

10 After a final mechanical inspection and the insertion of small tubes and other accessories, the complete transmitter is lifted off the main production line and placed in the shock-mounting plate which is eventually secured to the floor of the SCR-299 mobile communications truck



11 The transmitter is moved into an electrical testing room, where large tubes and plug-in tuning units are inserted. A dummy antenna is connected and the transmitter is keyed and modulated on five successive test frequencies between 1,500 and 18,000 kc

12 Finally, a top cover is installed and the transmitter is given a thorough cleaning by means of compressed air. It is then ready for Signal Corps inspection

TEMPERATURE COMPENSATION

An analysis of an uncompensated temperature error occurring in variable-frequency tank circuits employing ceramic capacitors for compensation

By HERBERT SHERMAN

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MILITARY REQUIREMENTS for the operation of radio equipment over wide temperature ranges have accentuated the problem of temperature compensation of tuned circuits.

One solution has been the development of the variable temperature coefficient ceramic capacitor to the point where well-controlled mass production is possible. This has increased the use of ceramic capacitors for temperature compensation. The extensive use of this type of compensation has introduced an uncompensated error in variable-frequency circuits which appears at all frequencies except the one for which the ceramic capacitor temperature coefficient is chosen.

Fixed vs Variable Frequency

In a fixed-frequency circuit, the temperature coefficient of the ceramic padding capacitor across the tank capacitor may be chosen so as to compensate for the change in capacitance of the tank capacitor or the change in inductance of the tank coil, subject to the present limitations of temperature coefficients of ceramic capacitors and the type of variation of tank capacitance and inductance with temperature.

In a variable-frequency circuit, it is well known that lumped changes in inductance or capacitance have varying effects over the frequency band covered by the circuit. For example, consider a 20 to 40-Mc capacitor-tuned circuit. Assume a padding capacitor is added which causes a frequency change of 100 kc at 20 Mc. It can be shown that this padding capacitor will cause a change of frequency of 800 kc at 40 Mc, a ratio of 8:1, although the band coverage is 2:1.

Let Δf_1 be the change in frequency at frequency f_1 due to the change in the lumped constants, and let Δf_2 be the change in frequency at frequency f_2, due to the same change in the lumped constants. Then, it may be easily shown that, in the following variable-frequency circuits where variable capacitance is used and

(a) Lump capacitance is changed, the change in frequency is

$$\Delta f_2 = \Delta f_1 f_2^3/f_1^3 \quad (1)$$

(b) Lump inductance is changed, the change in frequency is

$$\Delta f_2 = \Delta f_1 f_2/f_1 \quad (2)$$

Where variable inductance is used and

(a) Lump inductance is changed, the change in frequency is

$$\Delta f_2 = \Delta f_1 f_2^3/f_1^4 \quad (3)$$

(b) Lump capacitance is changed, the change in frequency is

$$\Delta f_2 = \Delta f_1 f_2/f_1 \quad (4)$$

Inductance vs Capacitance Compensation

Let us now consider a capacitor-tuned circuit, operating at frequency f_1, which is temperature compensated by a ceramic capacitor having a specified temperature coefficient. Assume that a temperature change causes a change in the fixed inductance of the circuit and that the ceramic capacitor temperature coefficient has been chosen so as to vary the lumped capacitance to compensate for this inductance change. At any other frequency f_2, the frequency drift due to these changes in the lumped constants is

$$\Delta f_2 = \Delta f_C - \Delta f_L \quad (5)$$

where Δf_C is the change in frequency at frequency f_2 due to the change in lumped capacitance as defined in Eq. (1), and Δf_L is the change in frequency at frequency f_2 due to the change in lumped inductance as defined in Eq. (2) (which is of opposite sign to Δf_C since Δf_C was arranged to compensate for Δf_L). Substituting Eq. (1) and (2) in (5),

$$\Delta f_2 = \Delta f_1 f_2^3/f_1^3 - \Delta f_1 f_2/f_1 \quad (6)$$

$$\Delta f_2 = \Delta f_1 \frac{f_2}{f_1}\left(\frac{f_2^2}{f_1^2} - 1\right) \quad (7)$$

It may be shown that the change in frequency Δf_1 at the frequency f_1, due to a small change in lumped inductance ΔL is given by

$$\Delta f_1 = \frac{1}{2}\frac{\Delta L}{L} f_1 \quad (8)$$

Substituting Eq. (8) in (7),

$$\Delta f_2 = \frac{f_2}{2}\frac{\Delta L}{L}\left(\frac{f_2^2}{f_1^2} - 1\right) \quad (9)$$

Equation (9) indicates that only at a single frequency is it possible to compensate for a change in lumped inductance with a lumped capacitance. At all other frequencies complete compensation is not possible, and the resultant error will become more serious as the frequency of the circuit increases, or as the percentage change in lumped inductance increases, or as the frequency changes from the corrected frequency. Thus, a circuit which has been capacitance compensated at 500 kc for a 0.1 percent change in inductance will have a frequency error of 0.15 percent at 1000 kc.

The above discussion does not take into account the error due to the dependence of the temperature coefficient of a variable capacitor on the degree of mesh of plates.

The necessity for compensating inductance changes by equivalent inductance changes rather than by capacitance changes has been indicated in an article by Mr. E. O. Thompson entitled "Temperature Compensated Wavemeter Coil," appearing in ELECTRONICS, Sept. 1943, page 148. This article discussed the temperature compensation of frequency-measuring equipment.

Feedback Amplifier for C

Practical application of feedback for impedance compensation in amplifier design gives wide-band performance with small sacrifice of other characteristics. Both electrostatic and electrodynamic deflection applications are covered.

By G. ROBERT MEZGER*

IN COMMON with all vacuum-tube amplifiers, an amplifier which is designed for electrodynamic deflection of a cathode-ray tube must be capable of maintaining a constant output potential with a constant input over a desired frequency range, in the presence of any stray capacitive loading which may be present in the output circuit.

Often this problem is intensified in the case of cathode-ray tube deflection amplifiers, because of the relatively high output potential which is demanded for full-scale deflection of the cathode-ray tube, and the wide frequency range over which they usually are required to operate. In many cases, also, the amplifier must be physically detached from the enclosure which mounts the cathode-ray tube. This type of design introduces additional load-circuit capacitance from the connecting cables and the cable-connection fittings.

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In conventional circuits the interelectrode capacitances between the deflecting electrodes and other electrodes of the cathode-ray tube, and other circuit capacitances, can present a load to the deflecting amplifier which is of the same order of magnitude as the plate-load resistor at frequencies as low as one-half megacycle per second. Variations of plate-circuit impedance of appreciable magnitude, therefore, can readily assume proportions which are of sufficient importance to be the determining factor in establishing amplifier performance.

Methods for controlling the undesirable effects of load-circuit capacitance usually include the reduction of the output impedance of the amplifier by the use of low values of plate-load resistors and the use of small amounts of inductance in the plate-circuit network to compensate for the shunting effects of stray capacitances at high frequencies.

Limitations Due to Plate Loading

Reduction of the plate-load resistor is a powerful method for attacking this problem, but it has the disadvantages of simultaneously increasing the plate dissipation of the output tubes of the amplifier, increasing the load on the power-supply equipment, and reducing the gain of the stage. The addition of inductance to the plate-circuit network of the amplifier makes it difficult to predict the performance of the amplifier under the effect of transients which may have high-frequency components. A knowledge of the transient performance of an oscilloscope amplifier is especially important, for the signals which are supplied to the input circuit of such an amplifier are usually of an unknown nature. At least in the case of the simpler plate-circuit networks which employ inductive compensation, reduction of the inductance to the value where overshoot of a square-wave

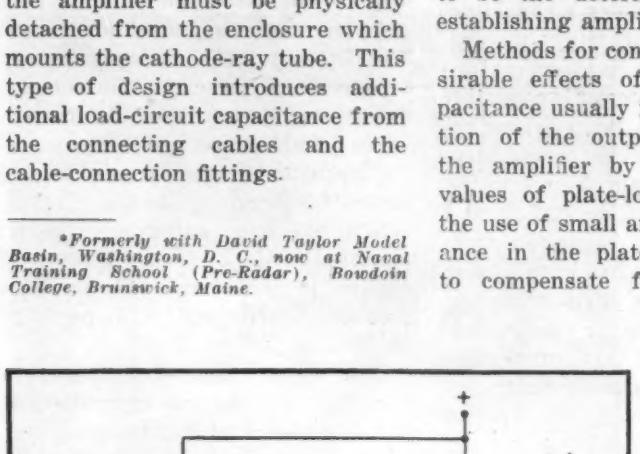

FIG. 1—General feedback amplifier circuit

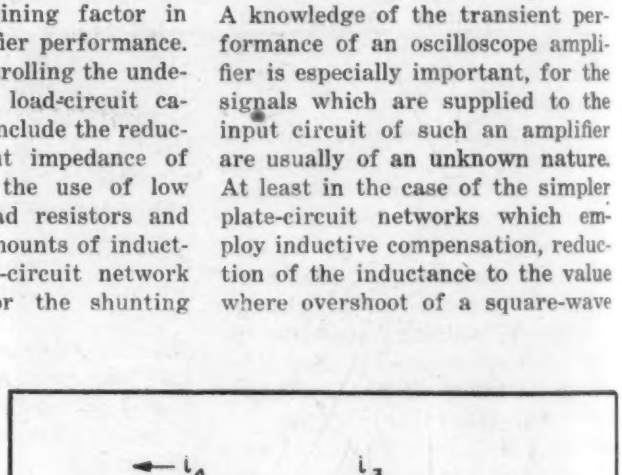

FIG. 2—Equivalent circuit for the determination of the effect of feedback upon r'_{p1}

C-R Oscilloscopes

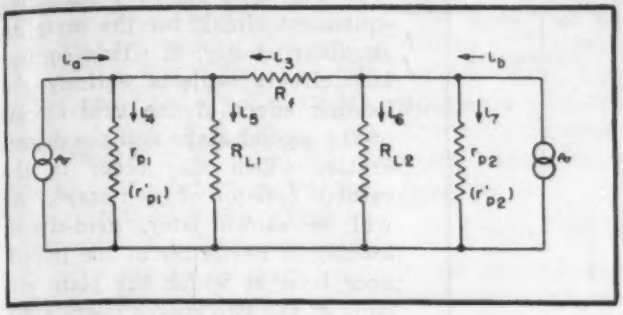

FIG. 3—Equivalent circuit for the amplifier of Fig. 1

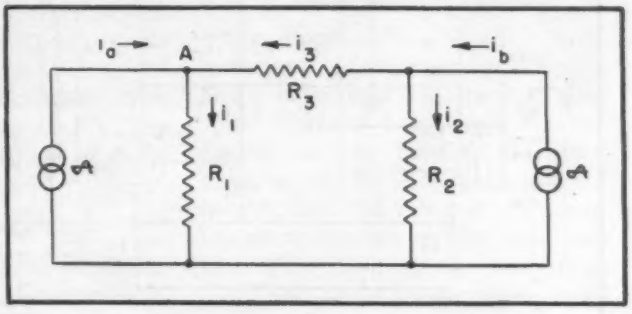

FIG. 4—Simplified form of the circuit of Fig. 3

test signal is not present requires such a small value of inductance as to make its effect questionable.

It would appear, therefore, that some method for reduction of the output impedance, which would not sacrifice load-circuit impedance and thereby transfer the power dissipation of the circuit to the plate of the vacuum tube, would prove of value. In special cases, where wide frequency-range is of prime importance, cathode-followers have been employed for the deflection of cathode-ray tubes. The low limit on the output potential available from the cathode-follower, however, has precluded its general adoption for such purposes.

Negative Feedback Method

Another method for reduction of the impedance level of the output circuit of a vacuum-tube amplifier is available in the effective reduction of internal plate resistance of a vacuum tube which is obtained through the use of negative voltage feedback. Because the internal plate resistance of a vacuum-tube amplifier is connected in shunt with the external load, reduction of this resistance will effect a reduction of the overall impedance level of the output circuit.

It has been shown[1,2] that the internal plate resistance r_p of a vacuum-tube amplifier changes under the influence of negative voltage feedback to a new value r'_p, which new value is lower than the internal plate resistance without feedback, and which is related to that value by the expression

$$r'_p = r_p/(1-\mu\beta) \qquad (1)$$

where μ is the voltage-amplification factor of the vacuum tube and β is the transmission factor of the feedback network. This new value of internal plate resistance changes the output impedance level Z'_0 of an amplifier with negative feedback from its value without feedback to a lower value which is given by

$$Z'_0 = \frac{r_p R_L}{r_p + (1-\mu\beta)\,R_L} \qquad (2)$$

where R_L is the resistance of the entire plate-circuit load network.

The reduction of impedance level of the output circuit of a vacuum-tube amplifier by the use of negative voltage feedback can be greater than 90 percent of the value without feedback. This fact is further developed in the Appendix. Such a method, therefore, is of particular interest in the case of cathode-ray tube deflection-amplifiers, where the high deflection potentials required often demand the use of expensive transmitting tubes and large power dissipations to obtain full-scale deflection.

General Feedback Amplifier Circuit

A general circuit[1] useful in deflection-amplifiers, and which conveniently includes negative voltage feedback, is shown in Fig. 1. Interconnection of the plates of V_1 and V_2 provides a simple feedback network which is reliable over the widest possible range of frequencies the amplifier may be required to pass.

In the amplifier of Fig. 1, the effects of negative voltage feedback in reducing plate-circuit impedance level are found not only in the output stage, whose grid and plate circuits are enclosed by the feedback network, but also in the plate circuit of the first stage. This permits both the first and second stages to operate with a high value plate-load resistor, while the impedance level, and therefore the effects of stray shunt capacitances, are kept at a practical minimum.

The reduction of the plate-circuit impedance level of the first stage may be shown by application of the principles of Thevenin's theorem to this circuit. This theorem states that, with respect to any single external circuit connected to any given pair of terminals of a network, the network can be replaced by a single branch having an impedance which is equal to the actual driving-point impedance of the network at these terminals and contains a single electromotive force which is equal to the open-circuit potential of the network across the given pair of terminals.

Equivalent Circuits for Plate-Circuit Impedance Level

If a generator is connected across the output terminals of a vacuum-tube amplifier, with the input signal to the amplifier zero, the current delivered by the generator will be determined by the output-impedance level of the amplifier. Thus, if a generator whose output potential is e_x is connected to the plate of V_1, if the load resistor for V_1 is removed (since it does not enter into this discussion), and if the input to this stage is short-cir-

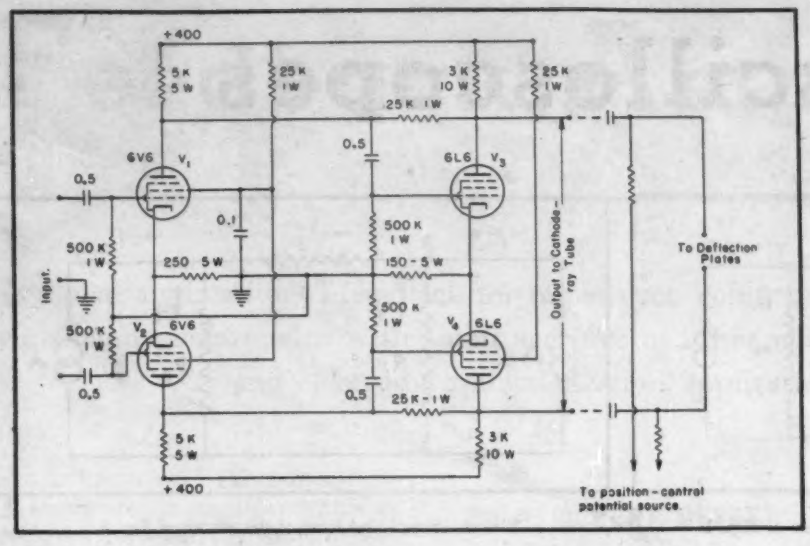

FIG. 5—Resistance-capacity coupled deflection amplifier

cuited, the equivalent circuit for the first stage of the amplifier may be represented as shown in Fig. 2. The generator whose output potential is $-A'_{v2}e_x$ represents the potential which is generated in the plate circuit of the second stage by the application of the voltage e_x to the input circuit of the second stage. Then, by the application of Kirchhoff's laws,

$$i_x = i_3 + i_4 \quad (3)$$

$$e_x - i_4 r_{p1} = 0 \quad (4)$$

$$e_x - i_3 R_f - A'_{v2} e_x = 0 \quad (5)$$

Solving simultaneously:

$$i_x = \frac{e_x}{r_{p1}} + \frac{e_x (1 + A'_{v2})}{R_f} \quad (6)$$

Equation (6) is an expression for the current which would be delivered into an impedance r'_{p1} by a generator which delivers a potential e_x. Then,

$$r'_{p1} = \frac{e_x}{i_x} = \frac{1}{\frac{1}{r_{p1}} + \frac{(1 + A'_{v2})}{R_f}} \quad (7)$$

$$r'_{p1} = \frac{r_{p1} R_f}{R_f + r_{p1} (1 + A'_{v2})} \quad (8)$$

The quantity r'_{p1} may be termed the effective internal plate resistance of the first stage under the influence of negative voltage feedback.

In a manner similar to the foregoing, it can be shown that the internal plate resistance r'_{p2} of the second stage with negative voltage feedback is

$$r'_{p2} = \frac{r_{p2}}{1 - \mu_2 \beta} \quad (9)$$

where r_{p2} is the internal plate resistance of the tube as determined from its plate characteristic, μ_2 is the voltage amplification factor of the tube and β is the transmission factor of the feedback network.

Equations (8) and (9), while accurate, are merely convenient forms for assigning the effects of feedback to the internal plate resistances of the vacuum tubes under consideration. This procedure is useful, for it is more difficult to establish mentally a physical concept of change in the value of a fixed, wirewound plate-load resistor than it is to imagine a variation in r_p of a vacuum tube. Equations (8) and (9), then, represent merely a simple means for visualizing the change which has been effected by the use of negative voltage feedback.

Equivalent Circuits for Output Impedance Level

The end point of the work is the reduction of overall plate-circuit terminal impedance. This may be determined by evaluating the shunt combination of r'_p and R_L, where R_L has the same significance as it has in Eq. (2). It also may be determined by a process exactly similar to that which was used to develop Eq. (8) and (9) but including R_L also in the plate-circuit network. Such a process will yield the following equations for Z'_{01} and Z'_{02}, the terminal impedances of the first and second stages respectively.

$$Z'_{01} = \frac{R_1 R_f}{R_f + (1 + A_{v2}') R_1} \quad (8a)$$

$$Z'_{02} = \frac{r_{p2} R_{02}}{r_{p2} + (1 - \mu_2 \beta) R_{02}} \quad (9a)$$

R_{02} is the complete load-circuit network resistance for the second stage. R_1 is the parallel resistance of r_{p1} and R_{L1}.

Allowable Simplifications

In Fig. 3 is shown a simplified equivalent circuit for the complete amplifier of Fig. 1. This equivalent circuit neglects entirely the loading effect of the grid circuit of the second stage and the degeneration which may occur in the cathode resistor of each stage. As will be shown later, grid-circuit loading is negligible at the impedance level at which the plate circuits of the two stages operate. In the practical amplifier for deflection of the electron beam of a cathode-ray tube, symmetric deflection always is used, and the common cathode load of push-pull amplifiers eliminates degeneration in the cathode circuit.

Figure 3 may be further simplified by combining the internal plate resistances and the plate-load resistors as shown in Fig. 4 so that

$$R_1 = \frac{r_{p1} R_{L1}}{r_{p1} + R_{L1}} \quad (10)$$

$$R_2 = \frac{r_{p2} R_{L2}}{r_{p2} + R_{L2}} \quad (11)$$

By the use of Fig. 4, the voltage gain, feedback-network transmission, and impedance level of the amplifier plate circuits may be calculated in the following manner:

Applying Kirchhoff's laws to Fig. 4

$$R_1 i_1 - R_2 i_2 + R_f i_3 = 0 \quad (12)$$

$$i_1 = i_3 + i_a \quad (13)$$

$$i_b = i_2 + i_3 \quad (14)$$

Solving these simultaneously,

$$i_1 = \frac{i_a (R_2 + R_f) + i_b R_2}{R_1 + R_2 + R_f} \quad (15)$$

$$i_2 = \frac{i_b (R_1 + R_f) + i_a R_1}{R_1 + R_2 + R_f} \quad (16)$$

$$i_3 = \frac{i_b R_2 - i_a R_1}{R_1 + R_2 + R_f} \quad (17)$$

and, from elementary vacuum-tube theory,

$$i_a = -g_{m1} e_{g1}, \quad (18)$$

$$\text{and } i_b = -g_{m2} e_1, \quad (19)$$

where g_{m1} and g_{m2} are the grid-plate transconductances of the first and second stages respectively, e_{g1} is the grid-signal potential for the first stage, and e_1 is the grid-signal potential for the second stage, or the potential from point A to ground in Fig. 4.

Gain Equations

From Eq. (15), (18) and (19)

$$e_1 = i_1 R_1 = \frac{-g_{m2} e_{g1} R_1 (R_2 + R_f) - g_{m2} e_1 R_1 R_2}{R_1 + R_2 + R_f} \quad (20)$$

$$\text{or } A'_{v1} = \frac{e_1}{e_{g1}} = \frac{-g_{m1} R_1 (R_2 + R_f) - g_{m2} A_{v1}' R_1 R_2}{R_1 + R_2 + R_f} \quad (21)$$

and

$$A'_{v1} = -\frac{g_{m1} R_1 (R_2 + R_f)}{(R_1 + R_2 + R_f) + g_{m2} R_1 R_2} \quad (22)$$

where A'_{v1} is the voltage gain of the first stage with feedback. That is, the reduction in voltage across R_1 which is caused by feedback voltage arriving from the second stage is arbitrarily assigned to the first stage in this analysis. This arbitrary concept is a useful approach to practical expressions for the characteristics of this amplifier.

Similarly, the output potential of the second stage, from Eq. (16), is

$$e_2 = i_2 R_2 = \frac{-g_{m2} e_1 R_2 (R_1 + R_f) - g_{m1} e_{g1} R_1 R_2}{R_1 + R_2 + R_f} \quad (23)$$

and th evoltage gain A'_{v2} of the entire amplifier with feedback then becomes

$$A'_{v2} = \frac{e_2}{e_{g1}} = \frac{-g_{m2} A'_{v1} R_2 (R_1 + R_f) - g_{m1} R_1 R_2}{R_1 + R_2 + R_f} \quad (24)$$

The voltage gain A'_{v2} of the second stage then is

$$A'_{v2} = \frac{A'_{v2}}{A'_{v1}} \quad (25)$$

This equation expresses the gain of the circuit between point A of Fig. 4 and the output terminals, and is a true expression for the gain of the second stage either with or without feedback, since all gain reduction due to feedback has been arbitrarily assigned to the first stage.

Equivalent Load Impedances

The load R_{01} into which the plate of the first stage feeds may be determined by reference to Fig. 3, from which it is apparent that

$$R_{01} = \frac{R_1 (R_2 + R_f)}{R_1 + R_2 + R_f} \quad (26)$$

The load into which the second stage feeds:

$$R_{02} = \frac{R_2 (R_2 + R_f)}{R_1 + R_2 + R_f} \quad (27)$$

The values of R_{01} and R_{02} given by Eq. (26) and (27) represent the load impedances seen by the plates of the first and second stages, respectively. They are the resistances which would determine the load line superposed on the plate characteristic family of the tube to define the operating conditions of the tube. They may be considered to represent, also, the plate load of a fictitious amplifier, similar to the amplifier of Fig. 1 in every respect, but without negative feedback.

Output Impedance Level

For any vacuum-tube amplifier, the load-circuit impedance level Z_0 may be shown to be

$$Z_0 = \frac{r_p Z_L}{r_p + Z_L} \quad (28)$$

where Z_L is the impedance of the load circuit and r_p is the internal plate resistance of the vacuum tube. In the case of the amplifier of Fig. 1, therefore, if there were no feedback present in the circuit, the load-circuit impedance level of the first stage would be

$$Z_{01} = \frac{r_{p1} R_{01}}{r_{p1} + R_{01}} \quad (29)$$

and the load-circuit impedance level for the second stage would be

$$Z_{02} = \frac{r_{p2} R_{02}}{r_{p2} + R_{02}} \quad (30)$$

When negative voltage feedback is added to these stages, the load-circuit impedance levels become, from Eq. (8), (9) and (28),

$$Z'_{01} = \frac{r'_{1p} R_{01}}{r_{p1}' + R_{01}} \quad (31)$$

and,

$$Z'_{02} = \frac{r'_{p2} R_{02}}{r_{p2}' + R_{02}} \quad (32)$$

If preferred, Eq. (8a) and (9a) may be used to determine the values of Z'_{01} and Z'_{02}. This would eliminate the need for evaluating Eq. (8), (9) and (26).

Design Considerations

Equations (29) and (30) have little practical value, except for purposes of comparison, because the value of R_{01} is based upon the resistive coupling between the plate circuits of the first and second stages; and the value of R_{02} bears the same relation to the plate circuit of the first stage. Equations (29) and (30) do, however, indicate the output impedance level of fictitious amplifiers with loads of R_{01} and R_{02} respectively, and they are therefore useful for comparison with the values of Z'_{01} *and* Z'_{02} to show the reduction in dynamic impedance level which has been obtained through the use of negative voltage feedback. Z'_{01} and Z'_{02} do, therefore, through their dependence upon R_{01} and R_{02}, reflect a less favorable and more accurate representation of the reduction in terminal impedance which is effected by negative voltage feedback than if only the internal plate resistance and the individual load resistance of each separate stage were considered. In other words, the circuit of Fig. 1 does impose slight additional plate-circuit loading on each stage, over and above the normal loading which is present in the absence of a feedback circuit of this type.

Evaluation of Eq. (31) and (32), as is performed for two practical

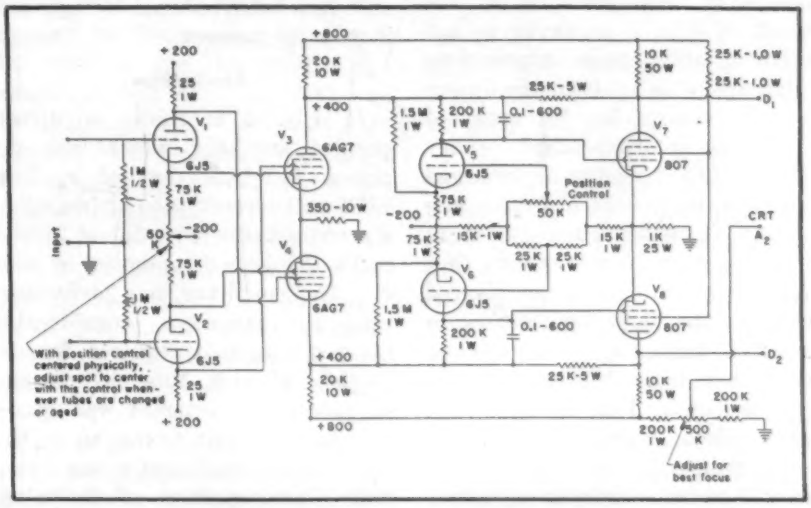

FIG. 6—Direct-coupled deflection amplifier

amplifiers later in this paper, will yield values which justify neglecting interelectrode capacitances in this analysis of the circuit. And these low values of output-impedance level show the usefulness of negative voltage feedback in reducing the deleterious effects of stray circuit capacitance on the response - vs. - frequency characteristic of an amplifier.

In order to evaluate the foregoing expressions, the transmission factor β of the feedback network must be evaluated. From Fig. 4

$$e_1 = R_1 g_{m1} e_{g1} - \frac{A'_{v2} e_1 R_1}{R_f + R_1} \qquad (33)$$

Also, from the general feedback equations

$$e_1 = \frac{R_1 g_{m1} e_{g1}}{1 - A'_{v_2} \beta} \qquad (34)$$

Solving (33) for e_1

$$e_1 \left(1 + \frac{A'_{v2} R_1}{R_f + R_1}\right) = R_1 g_{m1} e_{g1}$$

$$e_1 = \frac{R_1 g_{m1} e_{g1}}{1 + \frac{A'_{v2} R_1}{R_f + R_1}} \qquad (35)$$

and, by comparison[5] of (35) with (34)

$$\beta = -\frac{R_1}{R_f + R_1} \qquad (36)$$

The product $A_v\beta$, which is termed the feedback factor, is assumed to be positive if the sum of the applied potential and the feedback potential is larger than the applied potential. In the case of negative feedback, therefore, this product is negative, and the negative sign is assigned arbitrarily to the transmission factor β of the feedback network.

The foregoing theoretical development of the operation of the circuit of Fig. 1 arranges in undesirable order those expressions which are of interest in the design of such an amplifier, for many of them are interdependent. They could, however, readily be arranged in a more convenient order for calculation. It should be borne in mind in applying such expressions that they are given for an unbalanced amplifier. In their application to push-pull amplifiers it should be noted that this difference should be considered. For example, the plate-to-plate output impedance for a push-pull amplifier of this type will be twice the value obtained from equations (30) and (32). The value of the transmission factor of the feedback network will, of course, remain unchanged.

Practical Circuits

In Fig. 5 and 6 are shown two schematic circuits of practical deflection amplifiers for cathode-ray tubes which utilize the principles discussed herein.

Figure 5 shows a capacity-coupled amplifier designed to deflect a Type 5LP5 cathode-ray tube. The tube was operated at a second-anode potential of 1100 v and a third-anode potential of 2000 v. The amplifier will produce symmetrical deflection of the cathode-ray with either balanced or unbalanced input signals. For this amplifier, the significant design quantities have the following values:

$\mu_1 = 200$ $g_{m1} = 4\text{x}(10)^{-3}$ mho $r_{p1} = 50{,}000$
$\mu_2 = 120$ $g_{m2} = 6\text{x}(10)^{-3}$ mho $r_{p2} = 20{,}000$
$R_{L1} = 5000$ $R_{L2} = 3000$ $R_f = 25{,}000$

The calculated characteristics of this amplifier are:

R_1	= 4,540	r'_{p2}	= 1040
R_2	= 2,610	R_{01}	= 3910
A'_{v1}	= −4.85	R_{02}	= 2400
A'_{v0}	= +68.4	Z'_{01}	= 1145
A'_{v2}	= −14.1	Z'_{02}	= 725
r'_{p1}	= 1602 ohms	Z_{01}	= 3630
β	= −0.1527	Z_{02}	= 2140

All of the foregoing quantities are calculated for one phase of the amplifier, and voltage gains are referred to unbalanced input and unbalanced output.

No attempt has been made to evaluate R_{02} with load-circuit capacitance considered. Inasmuch as the design was approached as an attempt to render the stray capacitance as ineffective as possible, the impedance level of the output circuit has been reduced by approximately 80 percent.

Application

In Fig. 6 is shown a direct-coupled amplifier which was designed for deflection of a Type 5JP5 cathode-ray tube operating at a second-anode potential of 2000 v and a third-anode potential of 3000 v. The amplifier has deflection-voltage capacity considerably greater than that required for deflection of this tube by normal standards. An attempt was made, however, to limit operation to the use of only a small part of the essentially linear portion of the plate characteristic of the amplifier, in an effort to reduce amplitude distortion to a minimum.

Tubes V_1 and V_2 are cathode-follower stages, provided to increase the input impedance of the amplifier. Tubes V_3 and V_4 comprise the first amplifier stage of the assembly. Tubes V_5 and V_6 are the main elements of a constant-current direct-coupling network employed to reduce the average level of the signal potential appearing on the plates of V_3 and V_4 to a level suitable for the grids of V_7 and V_8, while maintaining uniform response to signals of zero frequency. Tubes V_7 and V_8 constitute the feedback-controlled output stage of the amplifier unit. The differentially connected feedback circuit between the screens of V_3 and V_4 and the plate circuits of V_1 and V_2 is provided to stabilize the amplifier against long-time drifts and differences which occur in the input tubes. The resistance of the plate loads in these two tubes is too small to affect seriously their operation as cathode followers. The feedback circuit, which is effective in reducing the impedance level of the output circuit, is provided by the connection between the plates of V_3 and V_7 and between V_4 and V_8.

For the amplifier of Fig. 6 the significant design quantities are:

$\mu_1 = 360$ $g_{m1} = 9\text{x}(10)^{-3}$ mho $r_{p1} = 40{,}000$
$\mu_2 = 63$ $g_{m2} = 5\text{x}(10)^{-3}$ mho $r_{p2} = 12{,}600$
$R_{L1} = 20{,}000$ $R_{L2} = 10{,}000$ $R_f = 25{,}000$

The calculated quantities are:

R_1	= 13,300	r_{p2}'	= 550
R_2	= 5,570	R_{01}	= 11,200
A'_{v1}	= −9.05	R_{02}	= 7,220
A'_{v0}	= +205	Z'_{01}	= 916
A'_{v2}	= −22.6	Z'_{02}	= 510
β	= −0.348	Z_{01}	= 8750
r'_{p1}	= 1030	Z_{02}	= 4580

All of the foregoing quantities are calculated for only one phase of the amplifier, and voltage gains are referred to unbalanced input and unbalanced output.

No attempt was made to evaluate R_{02} with load circuit capacitance considered. The design was approached as an attempt to render the stray capacitance as ineffective as possible, and the impedance level of the output circuit has been reduced by approximately 90 percent.

Application

Measurements of Z'_{01} and Z'_{02} on the circuit of Fig. 6 indicate close

correspondence to the values given here. Although a considerable sacrifice of voltage gain has been made in the second stage, it is believed that this is amply justified by a reduction in output impedance from approximately 4500 to 500 ohms. Used with a Type 5JP5 cathode-ray tube, this circuit has produced uniform spot deflection, as a function of frequency, from zero to 1.5 Mc. While this high-frequency limit of response seems rather low, it was adequate for the purpose at hand and was not investigated further. The characteristics of the circuit seem to indicate, however, that a considerably better figure for the high-frequency response limit should be obtained, on the basis of experience; and it is believed that the mechanical arrangement of the amplifier used for the tests of the circuit could be redesigned considerably to achieve improved high-frequency response with no change in electrical characteristics.

The particular value of β which was employed for the amplifier of Fig. 6 results merely from the choice of a convenient value for the resistor R_f. Experiments indicated, however, that attempts to increase the feedback materially beyond this value, in an effort to obtain even greater decrease of Z'_{out}, caused A'_v to decrease so rapidly as to question the value of any further decrease in output impedance.

Examination of the average plate characteristics of the Type 807 tube indicates that, in an amplifier circuit without feedback, it is impossible to achieve the output impedance level of the circuit of Fig. 6 without sacrificing output-potential swing, exceeding the plate-dissipation rating of the tube, or else sacrificing voltage gain even more by a reduction of screen potential.

Further Reduction of Impedance Level

It has been shown by Mayer[3] that the output impedance level of an amplifier can be reduced to zero, and the loss of gain through feedback considerably reduced by the proper combination of positive current feedback and negative voltage feedback. This should present some interesting possibilities for modes of attack upon the general problem of high-fidelity amplification.

While it is not necessarily true that the adjustment of a circuit for minimum output impedance level coincides exactly with the optimum feedback compromise for stabilization of the gain of an amplifier, nevertheless the problem of gain stability is very real with the circuit of Fig. 6, as it is in all direct-coupled amplifiers. Although a good measure of gain stabilization is inherent in this amplifier, through its direct-coupling circuit, this form of the circuit does not entirely exploit that possibility, and the additional stabilization of gain obtained with negative feedback was valuable in making the circuit absolutely reliable.

The advice of Mr. W. F. Curtis of the Structural Mechanics Section of the David Taylor Model Basin, particularly on the analysis of the circuit, is greatly appreciated. Various members of the staff of the Taylor Model Basin have examined the report and have made valuable suggestions. The circuit of Fig. 5 is an adaptation of a circuit first used by Mr. Geo. W. Cook, of the Electronics Section of the Taylor Model Basin, in the development of a general-purpose amplifier.

Appendix

The Effect of Negative Voltage Feedback Upon the Output-Impedance Level of an Amplifier. Consider the case of a negative feedback amplifier in which a certain fraction of its output potential is fed back to its input circuit. Such an amplifier is shown in Fig. 7. If, across the output of this amplifier, the load circuit is replaced by a generator of output potential E, as shown in Fig. 8, and if the input circuit is short-circuited, the current I delivered by the generator will be

$$I = \frac{E - \mu\beta E}{r_p} \qquad (37)$$

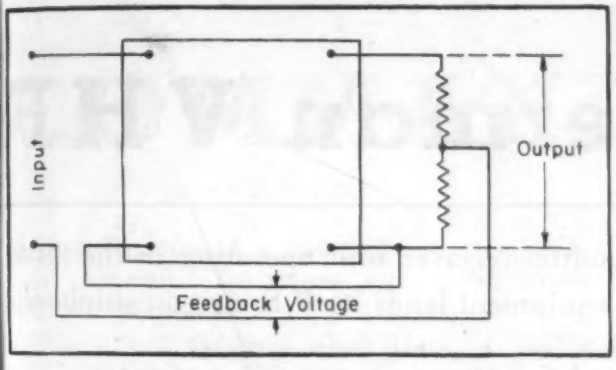

FIG. 7—Generic voltage-feedback amplifier

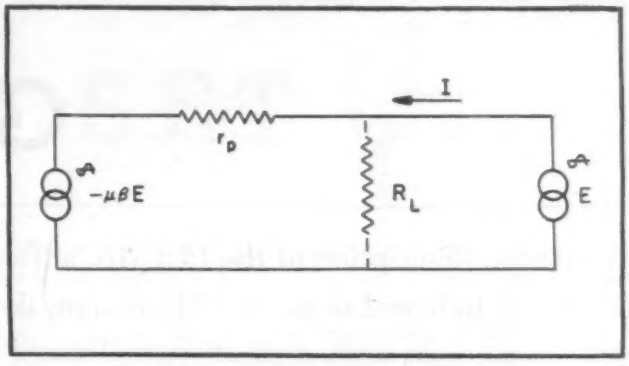

FIG. 8—Equivalent circuit of the amplifier of Fig. 7

where $-\mu\beta E$ is the potential resulting in the plate circuit from the potential fed to the input from the output, β is the transmission factor of the feedback network (negative in the case of negative feedback), and μ is the voltage-amplification factor of the vacuum tube. Then the impedance Z' seen by the generator will be

$$Z' = \frac{E}{-} = \frac{E\, r_p}{E - \mu\beta\, E} = \frac{r_p}{1 - \mu\beta} \qquad (38)$$

This is the dynamic value, with feedback, of the internal plate resistance of the vacuum tube. It is interesting to note from Equation (37) that the internal plate resistance of an amplifier, under the influence of negative voltage feedback, is reduced by the factor $1/(1 - \mu\beta)$, while the voltage amplification A_v of the same amplifier (without feedback) is reduced by

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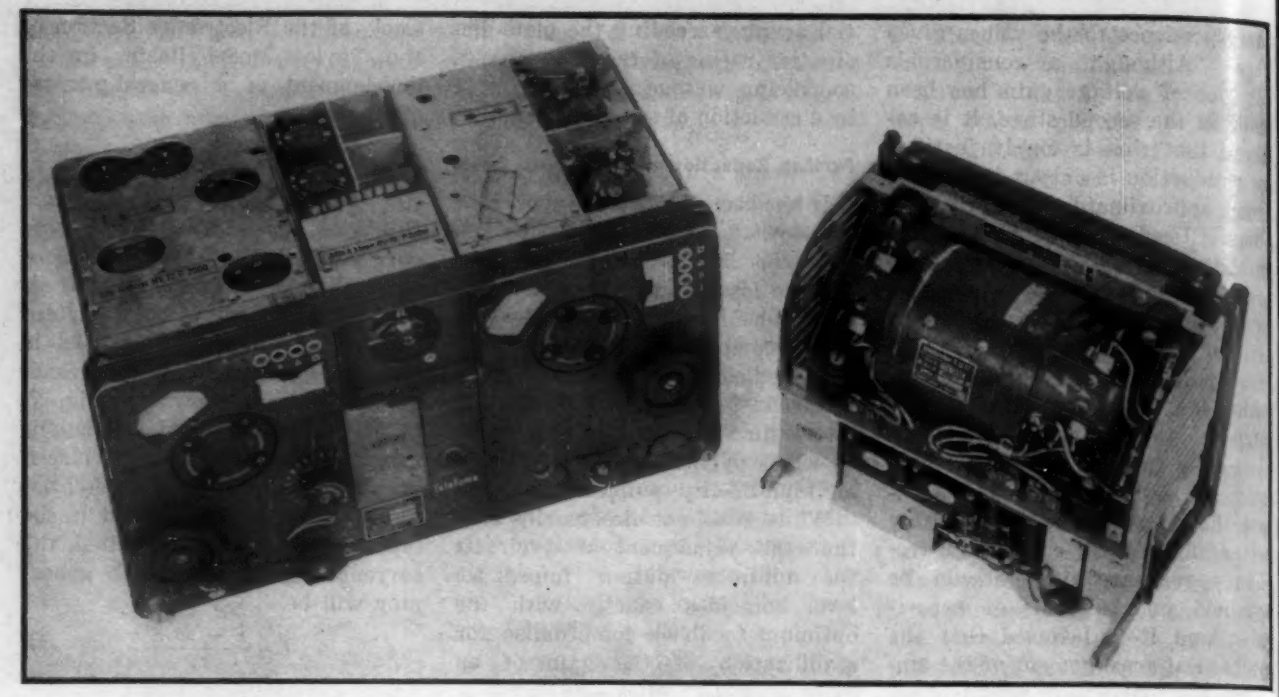

FIG. 1.—Model FUG-16 vhf transmitter-receiver, with companion dynamotor

German VHF C

A detailed description of the FUG-16, a transmitter-receiver unit operating in the 38-42 Mc band. Believed to be of 1935 design, the equipment lends itself to use on shipboard, in tanks and other motorized vehicles, as well as in aircraft

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THE GERMAN VHF COMMAND SET, model FUG-16, operates in the 38-42-Mc band. Figures 1 and 2 illustrate general construction.

This equipment is voice-operated and consists of a transmitter and receiver, fastened together by means of bolts. The whole unit is placed in a shock-proof mounting and is approximately 15 in. long, 9 in. high and 10 in. in depth, not counting a control box which can be located at a remote position. The assembly weighs 60 lb.

The complete unit is mounted in the operating position on hooks and is locked in place by means of two special screws located at the front of the panel. Plugs and jacks automatically make all necessary connections at the rear. They consist of brass pins which engage beryllium copper contacts tightly.

The unit has a power drain of 400 watts and gives an r-f output of approximately 10 to 13 watts with input voltage variations from 24 to 28 volts d.c. Filaments are normally kept running during stand-by periods.

Transmitter Performance

Power output of the transmitter is normally 12.9 watts, which represents an overall efficiency of 3.25 percent. This is considered very low. Considering size and weight, the overall efficiency should be greater, say 10 to 12 percent. Power output varies from 8 to 13 watts with an antenna having resistance of 20 to 100 ohms and 25 to 20 $\mu\mu$f capacitance. The optimum resistance and capacitance for maximum output appears to be 56 ohms and 23 $\mu\mu$f. Values of power output given here are for 100 percent modulation at 400 cycles.

The transmitter r-f tube lineup includes two type RL-12P-35 tubes in an ordinary self-excited oscillator and power-amplifier circuit. The tubes are pentodes capable of handling approximately 35 watts plate dissipation. The master oscillator and power amplifier tuning is ganged to one control.

Power is obtained from a dynamotor.

Two throat microphones are included as an integral part of a helmet which also contains earphones. Connections for earphones

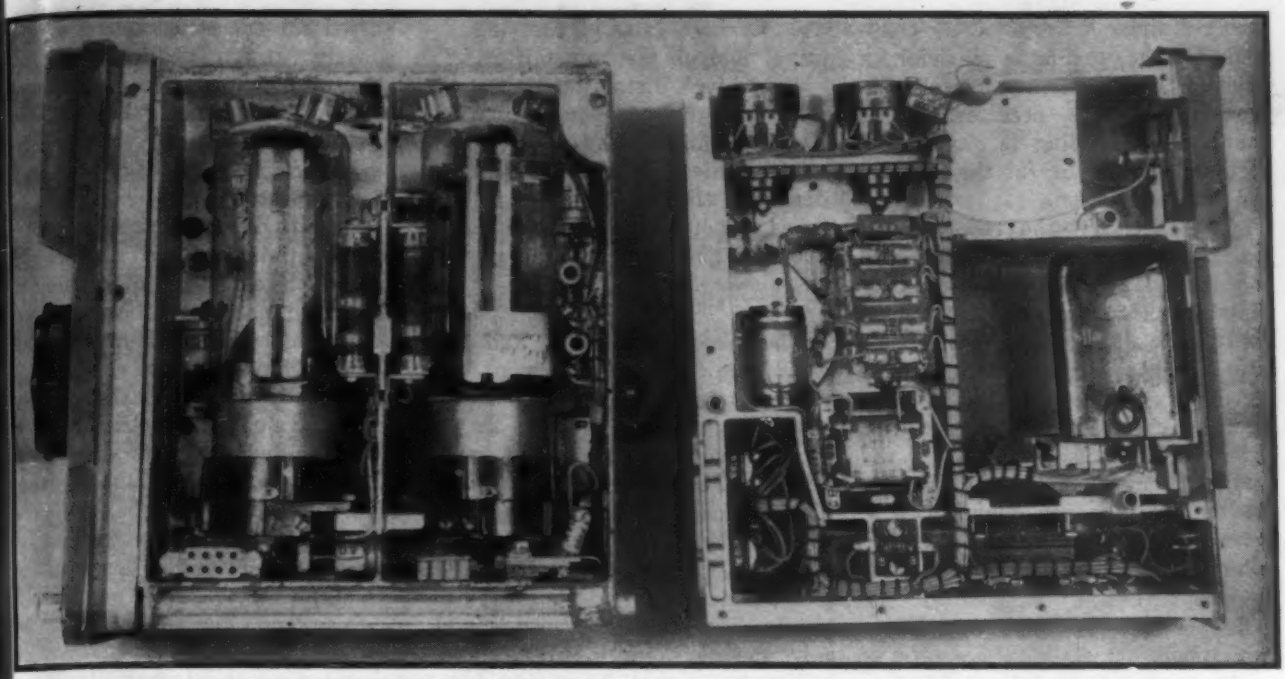

FIG. 2—Open views of the equipment, showing internal construction

F COMMAND SET

and mikes is through a small pull-apart cord plug. The transmitter can be grid-modulated up to 100 percent. A two-stage speech amplifier-modulator is used and the two tubes in this amplifier-modulator are the same type as those used throughout the receiver.

The audio fidelity to the transmitter varies about 6 db over a range of 200 to 6000 cps, which is satisfactory for voice transmission. Under test, the transmitter was modulated 65 percent by a 2400-cps audio signal.

Frequency stability of the transmitter, with changes in supply-battery voltage, is 0.0045 percent per volt. Power output changes 0.8 percent per volt between 23 and 28 volts.

The frequency variation of the transmitter over a temperature range of +50 deg to −30 deg is 0.04 percent. At temperatures above 40 deg C., the power output falls off considerably. The equipment was not designed, obviously, to meet conditions of high temperature and high humidity.

At different parts of the frequency band, the percentage frequency change with temperature change varies up to 0.075 percent, which clearly indicates that no provision was made for temperature compensation.

The frequency change with humidity is different in different parts of the band, but the average over the band is approximate 0.035 percent.

Receiver Characteristics

The receiver incorporates a conventional superheterodyne circuit, consisting of one r-f amplifier, first detector, beat oscillator, three stages of i-f amplification, second detector with avc and one stage of audio. The audio output is approximately 115 ma, which is sufficient to operate two head-sets.

The tubes used are identical in all stages. The RV-12P-2000 miniature, externally-shielded type, is employed throughout. The Germans apparently use this tube in many units operating from 300 kc to 42,000 kc.

Receiver sensitivity, with a 30 percent-modulated input signal and 10 milliwatts output, is approximately 4 μv. The signal-to-noise ratio is 5.

The bandwidth is 80 kc, 10,000 times down for standard output of 10 mw. The receiver will block at an output of 27 mw.

The i-f selectivity is 47 kc at 20 db, 73 kc at 40 db, and 103 kc at 60 db.

The overall fidelity varies ± 6 db from 120 to 4,000 cps.

Overall distortion, with a 30 percent-modulated signal, is 5 percent at 6000 cps and up to 23 percent at 400 cps, with standard output of 10 milliwatts. The receiver distortion varies with variation of percentage modulation from 4 percent to 40 percent and audio output varies from 2 to 54 mw.

Image rejection is relatively poor, as only 800 microvolts at the image frequency will give standard output (measurements taken at 8 μv input); this gives a ratio of about 100:1. This condition has been studied and the conclusion drawn is that trouble is caused by the method of coupling the oscillator to the first detector. The plate of

PERMANENT MAGNET Measurements

The concluding article of a series on permanent magnets, giving procedures for using the ballistic galvanometer, fluxmeter, magnetometer and permeameter to determine if sample magnets confirm the accuracy of design calculations and produce the required results

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PREVIOUS ARTICLES of this series discussed the fundamental principles of permanent magnet design and developed the fundamental design equations. Following this, minor hysteresis loops and magnet stabilization were considered, along with the principles involved in designing a magnet subject to a demagnetizing influence other than that exerted by the working gap. Finally, rules of good mechanical design of permanent magnets were taken up insofar as they apply to the various grades of Alnico.

From the information contained in these articles, an engineer—even one who has had no previous experience with the subject—should be able to design a permanent magnet to do a given job. He should be able to start from the basic requirements of a certain field strength in a certain gap, proceed through the calculations for magnet size, and emerge with a blueprint (complete with all tolerances) of the correct magnet for the job.

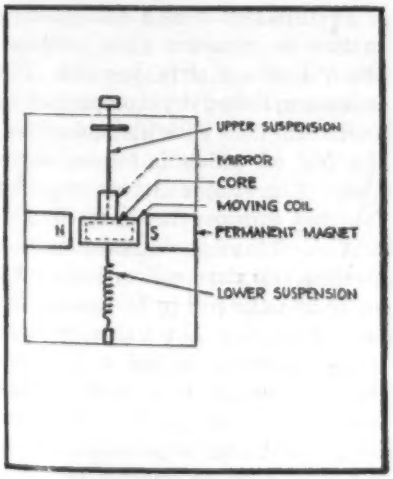


FIG. 3—Essential features of ballistic galvanometer used for magnetic measurements

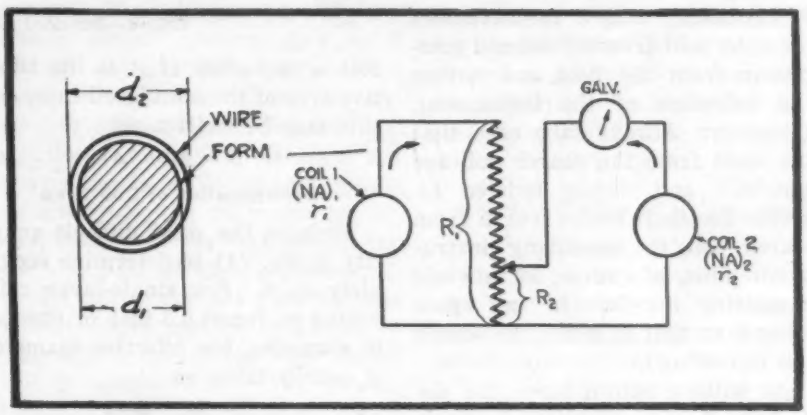


FIG. 1 (left)—Cross-section of single-layer search coil

FIG. 2 (right)—Circuit for measuring the NA product of a multi-layer search coil

From here the magnet manufacturer is well able to carry on, and the designer finds himself with nothing further to worry about until the time he receives his first sample magnets. At this time he is confronted with the problem of determining by actual test whether or not his design calculations were correct and whether or not the magnets he has in his possession are really the magnets for the job. He is thus introduced to the very important and very fascinating subject of magnetic measurements.

The purpose of the present article is to present this subject as completely as space will permit. As in the previous articles of this series, the assumption throughout will be that the reader is a competent engineer but that he is entirely unfamiliar with the tools of magnetics. Consequently, the discussion of magnetic instruments and methods of measurement will be confined to those which an engineer working with permanent magnets will find most useful. These will be presented in their order of *basic* importance.

Eliminated entirely from the discussion will be instruments of primary importance to the magnet manufacturer rather than the magnet user, such as permeameters, and methods of measurement of primary importance to the research engineer or physicist rather than the design engineer, such as methods of establishing the *NA* value of a primary search coil. (A method of establishing the *NA* value of a secondary search coil will be presented, however, as this is of great practical importance to an engineer engaged in magnetic measurements work.)

Almost all magnetic measure-

the r-f stage is very loosely coupled to the oscillator through a pickup coil, and is capacitively coupled to the detector. This method of coupling is simple and provides sensitivity at the expense of image rejection.

The fact that the receiver has relatively poor image rejection does not materially detract from its usefulness as the image is 2 times 3174, or 6349 kc, below the incoming signal. This is out of the frequency range used.

The i-f rejection ratio is well over 50,000.

Frequency variation with change of temperature per degree Centigrade averages 0.001 percent, which is considered excellent. Frequency variation with humidity is 0.09 percent, which is considered very poor.

At temperatures above 55 deg C and below 20 deg C, the antenna relay failed completely to operate during tests.

The equipment contains the same feature of four operational spot frequencies as the FUG-10 equipment, described in ELECTRONICS last month. The spot frequencies are set up separately on the receiver and on the transmitter.

Excessive distortion was observed due to frequency modulation. The transmitter was subjected to microphonics. Further examination disclosed that the design of the tubes was such as to produce microphonic tendencies.

Mechanical Design

The mechanical design and layout of the complete equipment was very well executed. Wherever possible, everything has been standardized, such as one type of knob, one type of tuning control, the use of standard die castings (which are practically identical with those of the FUG-10 equipment), one type receiver tube, 6 types of resistors, 4 types of capacitors, and only one transmitting tube type.

The equipment lends itself to extreme ease of operation, servicing and removal of parts. It also lends itself to mass production and interchangeability of parts or units. The use of diecast frames throughout (except for shields) presents a very favorable appearance as little or no machine operations are required for the construction of the chassis. It is noticed that no lacquer or paint is used on soldered joints. Not a single lock washer is used on the entire equipment. No corrosion was noticed on any of the joints.

Component standardization, which minimizes the number of values of resistors and capacitors needed, in many cases has produced loss of efficiency. However, the Germans have grouped resistors in series and parallel so that nearly correct values are obtained for critical circuits. Tests show that, by using a correct value resistor or a different type tube, the performance of this equipment can be increased by over 300 percent.

A single meter is used and merely reads antenna current, which is an adequate indication of the overall operation of the transmitter.

Servicing this equipment is a fairly simple and routine job, with very little training required. In the field, replacements can be made with only a few tools. Checking and testing can be accomplished while the gear is in place in an

(*Continued on page* 300)

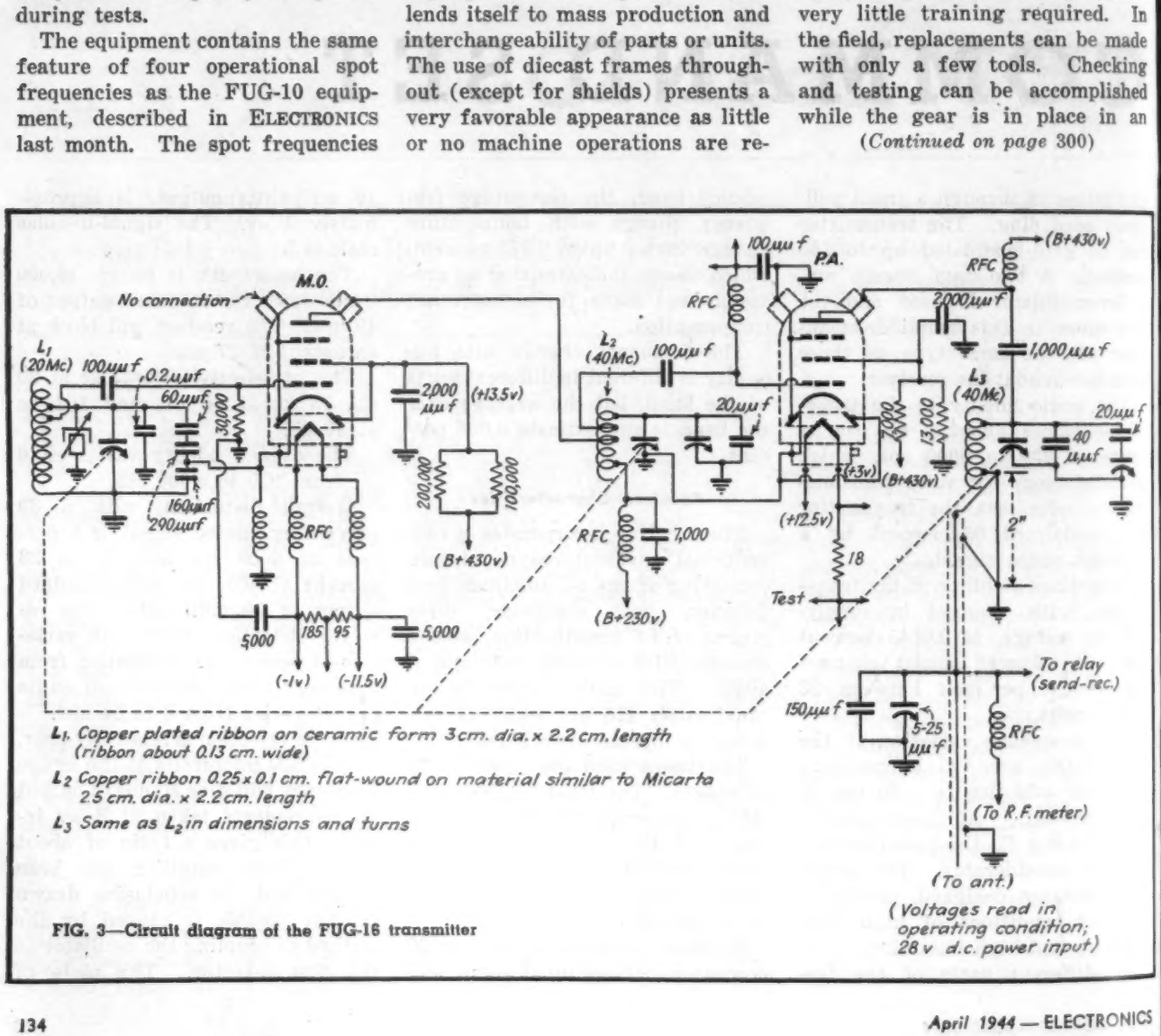


FIG. 3—Circuit diagram of the FUG-16 transmitter

vanometer pointer displacement is zero. (During the withdrawal the pointer may swing off zero but if it swings back to zero upon completion of the withdrawal, the potentiometer may be assumed to be in balance.) At balance,

$$\frac{(NA)_1}{(NA)_2} = \frac{R_1 + r_1}{R_2} \qquad (4$$

From this the NA value of the unknown coil is obtained.

The potentiometer in Fig. 2 may be of the slide wire type, and R_1 and R_2 measured by means of a Wheatstone bridge after balance is obtained. It is more convenient, however, to use a pair of decade boxes for this purpose, and read the values of R_1 and R_2 directly off the dials of the boxes. The values of r_1 and r_2 are the simple d-c resistances of coils 1 and 2.

The standard coil of known NA value may be a single-layer coil the NA of which had been computed by means of Eq. (2) and (3), or it may be a single-layer or multi-layer coil the NA value of which has been certified by the National Bureau of Standards or some other competent laboratory. To obtain balance, coils 1 and 2 must be connected so their instantaneous voltages have the relation shown by the arrows of Fig. 2.

Ballistic Galvanometer

Perhaps the most universally used instrument for primary magnetic measurements is the ballistic galvanometer. This is an extremely accurate instrument (under proper conditions, accuracies of the order of 0.1 percent may be realized) identical in construction to an ordinary galvanometer except that it has a very high natural period, usually 25 to 30 seconds or more.

The essential parts of a ballistic galvanometer are shown in Fig. 3. Current is conducted in and out of the moving coil by means of the upper and lower suspensions. As ordinarily used, a search coil, connected to the suspensions, is withdrawn from the field under test. A beam of light, focused on the galvanometer mirror, indicates the deflection of the moving coil on a scale located at a distance from the galvanometer. By calibration, the *maximum* deflection is then interpreted in turn into interlinkages, flux lines, and flux density.

The ballistic galvanometer reads total current, Q, or interlinkages, $N\phi$. (Proof of this is given in the Appendix).

Now, let us investigate the actual operation of the ballistic galvanometer. It is most common, when making a test, to include the calibrating equipment in the circuit. Thus, in addition to the search coil and the galvanometer, the circuit would incorporate a standard mutual inductance, a standard milliammeter or potentiometer for precise current readings, a reversing or current-breaking switch, a low-voltage source of very steady direct current such as a storage battery, and a variable resistance (a decade box, for instance) for adjusting this current. Additional variable resistances are generally placed in series and in parallel with the galvanometer itself, in order to vary the sensitivity and damping of the instrument.

The most commonly used ballistic galvanometer circuit is shown in Fig. 4. In actual use, the search coil is removed from the field under test and the maximum deflection of the galvanometer noted. With the search coil still in the circuit (but free of all fields), the current i is adjusted in the calibrating circuit to a value such that when the switch S is opened the galvanometer deflection is approximately the same as previously. (Before all readings, of course, the galvanometer light spot must be brought back and carefully set on zero). The current at this point is carefully noted. The flux density (or total flux or interlinkages) of the field under test may now be computed on the basis that the galvanometer deflection will be proportional to the total change of interlinkages in the circuit:

$$(N\phi)_T = KD_T \qquad (5)$$

where $(N\phi)_T$ represents the interlinkages between search coil turns and the flux threading them, K is the proportionality constant, and D_T is the galvanometer deflection as the search coil is removed from the field under test.

To evaluate K in Eq. (5), let us study the voltage induced in coil a-a of the standard mutual inductance in Fig. 4 as the calibrating current i is suddenly reduced to zero (this is the current which when suddenly broken gives a galvanometer deflection D_c approximately equal to D_T).

$$e = N_a \frac{d\phi_a}{dt} \times 10^{-8} = M\frac{di}{dt}, \text{ and therefore}$$

$$(N\phi)_a = Mi \times 10^8 \qquad (6)$$

where $(N\phi)_a$ represents interlinkages between turns of coil a-a and the flux threading them. This flux arises from current i in the turns of coil b-b. M is the value of mutual inductance in henrys between coils a-a and b-b, and i is the calibrating current in amperes. The deflection D_c is proportional to $(N\phi)_a$, and since D_c is approximately the same as D_T, the constant of proportionality, K, is the same as that in Eq. (5). Therefore,

$$(N\phi)_a = KD_a, \text{ or}$$

$$K = \frac{(N\phi)_a}{D_a} = \frac{Mi \times 10^8}{D_a} \qquad (7)$$

Substituting Eq. (7) into Eq. (5),

$$(N\phi)_T = Mi \times 10^8 \times \frac{D_T}{D_a}$$

Expressing M in millihenrys and i

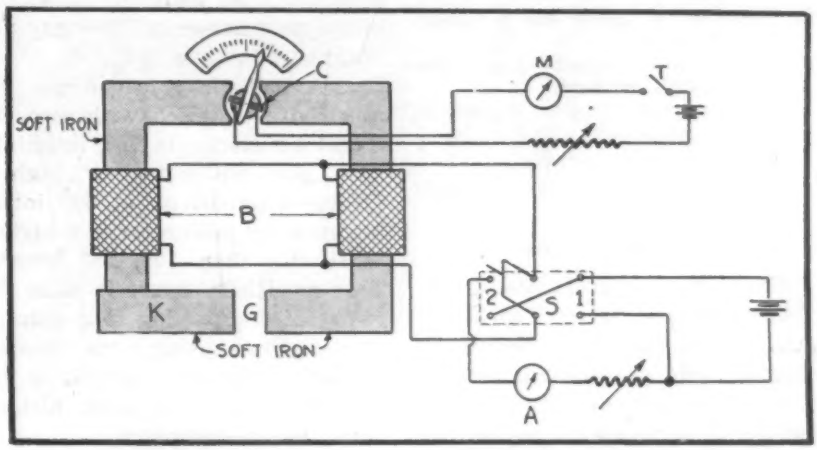


FIG. 5—Essential features of a magnetometer as used to secure readings that are reliable indications of residual induction and coercive force

ments are performed with the aid of a search coil.

Use of Search Coil

This most useful flux-responsive device consists merely of a number of turns of wire (usually wound in a single layer) about a form, the size and shape of which is proportioned to coincide with the space in which the measurements are to be made. After the coil has been correctly located in the magnetic field it is to measure, it is connected to the indicating device to be used (usually a ballistic galvanometer or a fluxmeter) and a measurement taken by withdrawing the coil completely from the field and noting the deflection of the instrument. (Caution: Always take care that the leads from the search coil are carefully and closely twisted together for their entire length from search coil to measuring instrument. This, of course, is to avoid measuring the field in any space other than that in which the search coil is resting).

As will be shown later, the deflection of the indicating device is proportional to the interlinkages which existed between the search coil and the magnetic field. (The interlinkages existing between a coil and a magnetic field are the product of the number of turns of the coil by the number of flux lines threading these turns.) Consequently, total interlinkages $= KD$, where K is the calibration constant of the instrument, and D is the deflection of the instrument.

It follows, then, that the total number of flux lines threading the search coil is $\phi = KD/N$, where N is the number of turns on the search coil.

Sometimes ϕ is all that is desired. Frequently, however, the average flux density B through the search coil is required. If A is the effective area of the search coil in sq cm, this may be written as

$$B = KD/NA \qquad (1)$$

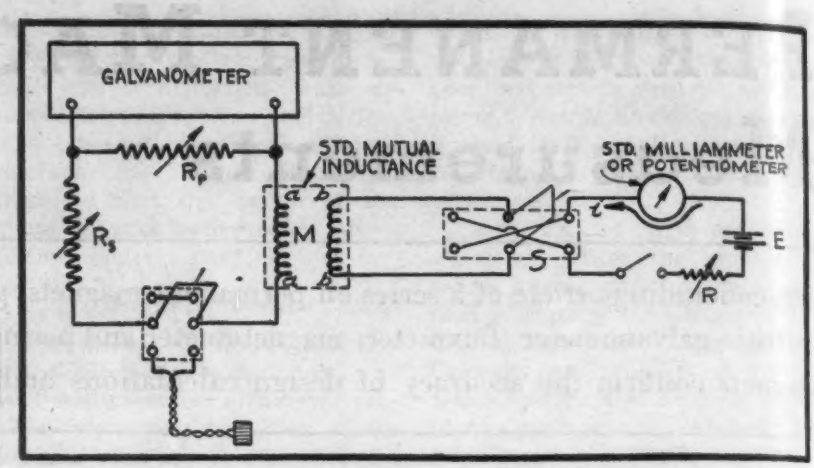


FIG. 4—Standard ballistic galvanometer circuit

Determination of Coil Area

Perhaps the most difficult quantity in Eq. (1) to determine accurately is A. For single-layer coils wound on forms 0.3 inch or greater in diameter, the effective diameter is usually taken as

$$D = (d_1 + d_2)/2 \qquad (2)$$

where d_1 and d_2 are as shown in Fig. 1. The effective area then is

$$A = \pi D^2/4 \qquad (3)$$

The effective area computed in this manner may be shown theoretically to be incorrect, but the error is small and completely dwarfed by substantially greater inaccuracies in the measuring instrument systems themselves. For this reason and the fact that the exact formulas are more complicated, Eq. (2) and (3) are universally used for the determination of the effective area of a single-layer search coil.

Multi-Layer Search Coils

The determination of the effective area of a multiple-layer search coil is quite a different problem. The difficulties encountered find their source not in the mathematical problems that arise in connection with the formulation of correct equations, but rather in the mechanical troubles involved in making the requisite measurements accurately. Values for d_1 and d_2 of Eq. (2) may be measured quite easily and accurately by means of a micrometer, but it is altogether a different matter to measure the outside diameters of additional layers of wire when these additional layers may or may not fit into the grooves of preceding layers and may or may not sink to a uniform depth when they do fit. All in all, the problem of obtaining accurate measurements on a multi-layer search coil is a fairly hopeless one even with the observation of the most stringent precautions. For this reason the effective area of a multi-layer coil is measured rather than computed.

Measuring *NA* of a Coil

In Eq. (1) the product of N and A appears in the denominator. This product is a constant of the coil and is probably more frequently used in computations than either of its components by themselves. If the NA of a coil is known, its effective area is easily determinable, it being assumed that the turns of the coil were counted when they were wound.

Fortunately it is a fairly simple matter to measure (not compute) the NA of a multi-layer coil. This is accomplished by comparison in a uniform field with a standard coil, the NA of which is known accurately. The simple circuit employed for this purpose is shown in Fig. 2. Coils 1 and 2 represent respectively a standard coil of known NA value and the coil to be tested. The coil of higher NA value must be in the position of coil 1. The two coils are placed in a uniform field with their axes parallel. They are then withdrawn simultaneously (or the field reduced rapidly to zero), and the potentiometer sliding contact is adjusted so that upon withdrawal from the field the net gal-

PREVIOUS ARTICLES

Permanent Magnet Design,
p. 126, Dec. 1943

Designing Stabilized Permanent Magnets,
p. 118, Jan. 1944

Mechanical Problems of Permanent Magnet Design,
p. 126, Feb. 1944

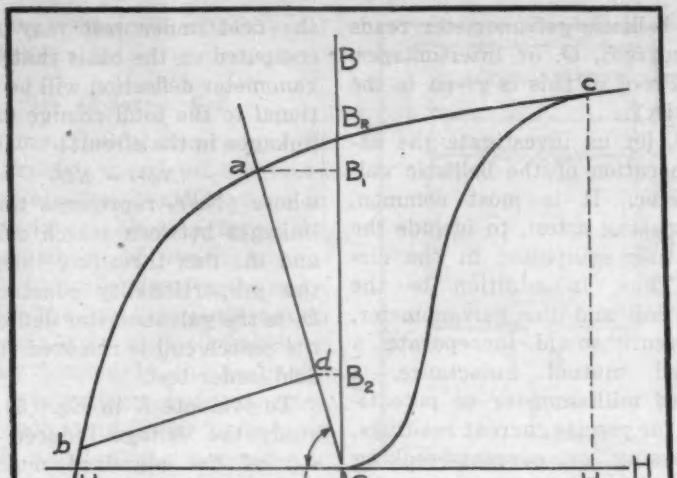


FIG. 6—Curves of actions taking place during a magnetometer test

in milliamperes, this becomes

$$(N\phi)_T = 100\, M i \times \frac{D_T}{D_e} \qquad (8)$$

The total flux threading the search coil is obtained by dividing Eq. (8) by the number of turns, N, on the search coil:

$$\phi = \frac{100\, Mi}{N} \times \frac{D_T}{D_e} \qquad (9)$$

The average flux density through the search coil is obtained by dividing Eq. (9) by the area of the search coil in square centimeters:

$$B = \frac{100\, M\, i}{NA} \times \frac{D_T}{D_e} \qquad (10)$$

The meanings of the symbols in Eq. (8), (9) and (10) are repeated here for convenience:

$(N\phi)_T$ = interlinkages between search coil and magnetic field under test.
ϕ = total number of flux lines threading search coil, in maxwells.
N = number of turns on search coil.
B = average flux density through the search coil, in gausses.
A = area of search coil in square centimeters.
M = value of standard mutual inductance, in millihenrys.
i = value of calibrating current in milliamperes.
D_T = search coil deflection.
D_e = calibration deflection (approximately equal to D_T).

Equipment Needed

The correct values to use for the circuit parameters of Fig. 4 depend a great deal, of course, on the magnetic and physical magnitudes of the fields to be measured, on the number of turns on the search coil, etc. However, a good general laboratory set-up for Fig. 4 might consist of the following items:

1. Storage batteries of from 6 to 12 volts for E.

2. A standard milliammeter of double range, 0-30 and 0-150 milliamperes. A potentiometer is a preferable alternative.

3. A standard mutual inductance of 50 millihenrys for M.

4. A four-dial decade box, 0-9999 ohms in steps of one ohm, for R.

5. A four-dial decade box, 0-9999 ohms in steps of one ohm, for R_s.

6. A four-dial decade box, 0-9999 ohms in steps of one ohm, for R_p. When R_s is adjusted to give a convenient galvanometer deflection in connection with the particular search coil being used and the particular field being tested, R_p will be adjusted to such a value that the resistance of the external network seen by the galvanometer is equal to the critical damping resistance of the galvanometer. This may not always be possible to do.

7. A ballistic galvanometer the sensitivity of which with zero external resistance is 700 interlinkages per millimeter or higher. (Note—a sensitivity of 600 interlinkages per millimeter is a higher sensitivity than 700, *not* lower.) This sensitivity figure is to be interpreted as applying to a galvanometer set-up having a scale located approximately perpendicular to the light beam and one meter distant from the galvanometer.

8. Suitable search coils and switches.

Next in basic importance to the ballistic galvanometer in making magnetic measurements is probably the flux meter.

Fluxmeter

A meter for measuring flux consists essentially of an ordinary d'Arsonval movement and a scale calibrated in terms of interlinkages. The restoring torque is made as near zero as possible. The deflection of the pointer of such an instrument is proportional not to the rate of flow of charge through the moving coil (as in an ammeter) but rather to the total quantity of charge moved through the moving coil. Thus the fluxmeter is an instrument which reads total current or interlinkage change.

Actually, in commercial models of this instrument, the restoring torque is close to, but very seldom equal to, zero over the entire scale range. This is due to the fact that current must be lead to and from the moving coil by some means or other and the ordinary means used are insufficiently pliant to forbid the self-exertion of some influence on the coil.

The common accuracy for commercial fluxmeters is 2 percent. This may be improved somewhat if the fluxmeter is used in connection with a calibrating circuit similar to that of Fig. 4.

Magnetometer

The ballistic galvanometer and the fluxmeter are the two commonly used instruments in the laboratory. The fluxmeter is also used frequently and satisfactorily as a production testing instrument, but in this respect it is probably less satisfactory than either the magnetometer or the production permeameter. These are the commonly used instruments in the production inspection department and have proved their worth over and over again.

Figure 5 shows schematically the basic layout of the magnetometer. Operation of this instrument is as follows: The piece to be tested is placed in gap G and movable member K is closed down upon it so that good magnetic contact is made at both ends of the specimen. Incidentally, the contact-making ends of the specimen are usually ground

smooth and parallel before test. The test specimen is now in a soft iron circuit completely closed except for the gap provided for moving coil *C*. Next, switch *T* is closed and current supplied to coil *C*. This current, as read by milliammeter *M*, is adjusted to some predetermined value. Next, switch *S* is closed in position 1 and a heavy magnetizing current put through coils *B*. (In most instruments it is essential to provide a mechanism to interrupt the current through coil *C* while switch *S* is closed in either position 1 or 2. This is to prevent the pointer from breaking or bending itself against the pointer stops). Switch *S* is held in position 1 for a matter of 3 or 4 seconds, or long enough for the current to completely build up in coils *B*, and is then opened.

The test specimen is now magnetized and provides the field for the operation of the d'Arsonval movement of which coil *C* is a part. The pointer deflects across the scale and a reading is taken when it comes to rest. After this reading is taken, switch *S* is closed in position 2 and a much smaller current put through coils *B* in the *opposite* direction to that previously. This current, as measured by ammeter *A*, is adjusted to a previously determined value and must always be adjusted in such a way that the current is *increased* to this value, never decreased to it. If the mark is overshot, the test is valueless and the cycle must be repeated from the start.

Switch *S* is held in position 2 for three or four seconds and then reopened. The test specimen has now been partially demagnetized and will supply a much weaker field to coil *C*. A second reading of the pointer deflection, which of course is proportional to this field, is taken at this point. The specimen is removed from the gap *G*, the next piece inserted, and the cycle repeated.

The two readings taken during the test form an excellent production index of the quality of the magnet tested. Of course, the various current values used in the test will in general differ for pieces of different size and shape (will *not* differ, however, between pieces of the same size and shape). The specification of the value of the demagnetizing test current and the specification of the low limits of acceptability for the two magnetometer readings must be decided upon as a result of an interpretation of the usage requirements of the particular magnets in question.

Magnetometer Principles

Reference to Fig. 6 and the second article of this series will make clear the action taking place during a magnetometer test. Assuming that the magnet is initially demagnetized when placed in the magnetometer (this is *not* a necessary condition to the proper functioning of the magnetometer) the flux density in the magnet will rise along the curve *oc* when the switch *S* is closed in position 1. Sufficient current must be put through coils *B* to assure that the magnet operating point carries beyond point *c*, i.e., to assure that the magnet is saturated. When switch *S* is opened, the magnet operating point runs down the curve cB_2a to point *a*, and the first reading will be proportional to the flux density value, B_1. (Note that the operating point goes to *a*, not B_2. This, of course, is due to the small gap introduced into the soft iron circuit of the magnetometer to allow operation of coil *C*). When switch *S* is closed to position 2, the operating point will continue down the demagnetization curve to a point (depending on the value of demagnetizing current used) shown as *b*. Then, as the switch is opened, the operating point travels up minor hysteresis loop *bd* to point *d*, and the second reading will be proportional to the flux density value, B_2.

While the magnetometer gives no answers in terms of absolute quantities and doesn't even give answers in terms of points on the demagnetization curve, it nevertheless gives two readings on each test piece, the first of which is a good indication of the residual induction of the piece and the second of which is a good indication of the coercive force. (This latter statement is predicated on the proper adjustment of the demagnetizing current during the test.) Thus, by means of this simple test, it is possible to determine rapidly whether or not the demagnetization curve of the magnet under test conforms, at least near its end points, with minimum established requirements for that magnet. The method is extremely rapid (one machine can test 200 magnets per hour if properly set up) and is used by magnet purchaser and magnet manufacturer alike.

Use of Production Permeameter

The production permeameter is shown schematically in Fig. 7. Its operation is as follows:

The piece to be tested is very carefully demagnetized (this is important) and inserted in the gap of the production permeameter. A search coil, *C* of a size to permit it to just slip over the test specimen, is placed into position and the mag-

(*Continued on page* 385)

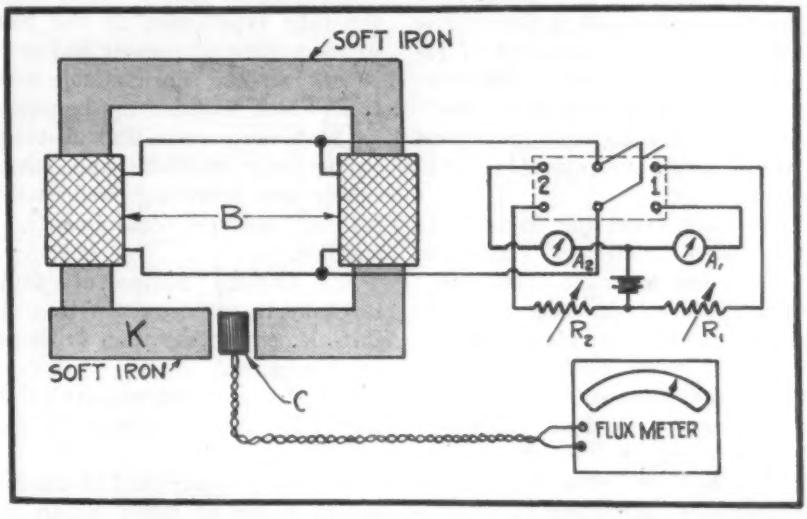
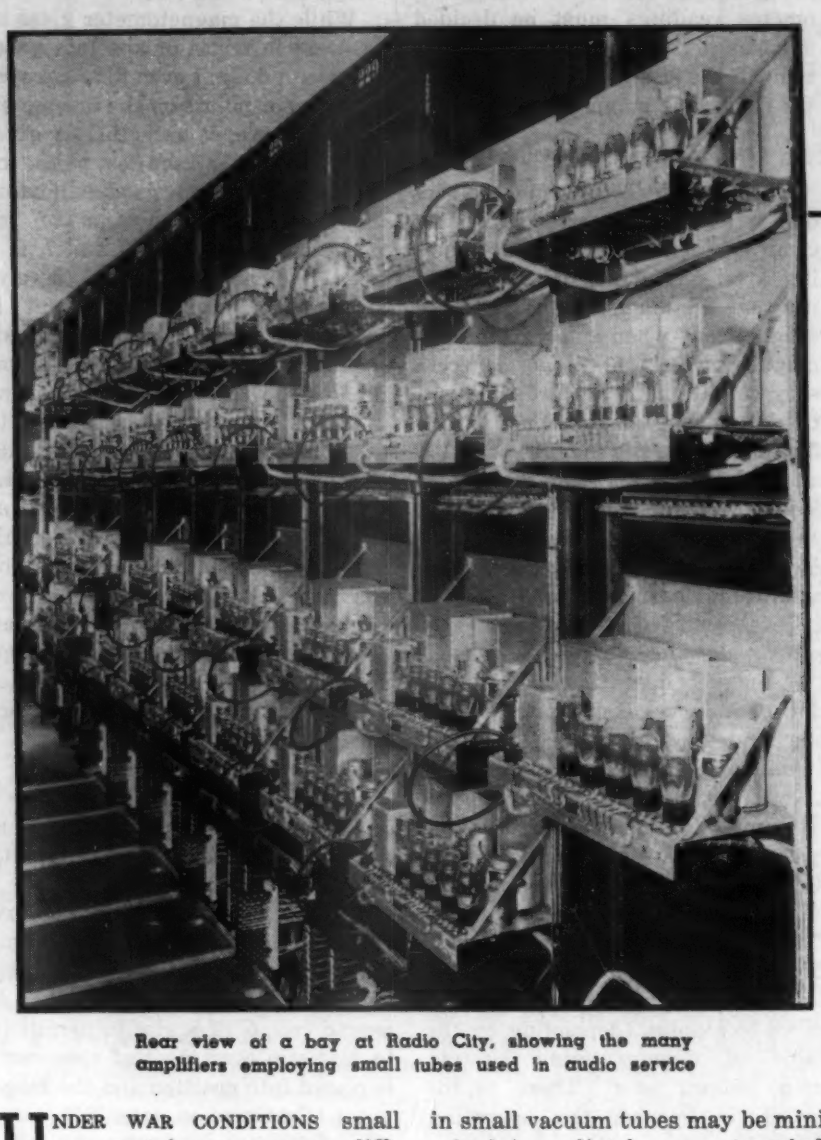


FIG. 7—Essential features of a permeameter designed for production-line use

CONSERVING Small Tube

By C. A. RACKEY
Audio-Video Facilities Engineer
National Broadcasting Company
New York, N. Y.



Rear view of a bay at Radio City, showing the many amplifiers employing small tubes used in audio service

UNDER WAR CONDITIONS small vacuum-tubes are more difficult to procure. The number of tube types produced is arbitrarily reduced and the availability of remaining types varies. Furthermore, general performance standards may be somewhat lower and manufacturing variations tend to increase.

The audio operating engineer is faced with a distinct small-tube problem and he must make every effort to solve it in order to maintain his plant in good working condition. The problem divides broadly into two parts: (a) Means of dealing with initial variations in performance characteristics and (b) methods of insuring normal life and even increasing it.

Seven methods by which troubles in small vacuum tubes may be minimized immediately come to mind:

(1) Reduce the number of different tube types used in the plant by modifying equipment and so, in effect, increase the available stock from which selection can be made.

(2) Make certain that all tubes, particularly rectifiers and output tubes, are operating well within rating. Reduce requirements, if possible.

(3) Analyze equipment faults carefully to make certain that circuit elements other than tubes are not the cause.

(4) Use external mechanical or electrical devices designed to protect tubes.

(5) Adapt equipment to use substitute types of tubes which are more readily procurable.

(6) Use all tubes to the very end of their useful life.

(7) Shut off equipment when it is not in use.

Tube "Selection"

Small tubes are not absolutely uniform in their characteristics, because of inevitable variations under conditions of economical quantity production. There is also some variation between similar types of different manufacture and between different lots or "runs" of the same type by any one manufacturer. For this reason some suppliers offer "selected" tubes, which are available at increased cost for critical applications.

The user may himself employ selection, provided a sufficient number of tubes of the required type are available. This suggests a study of equipment with a view toward possible changes in tube line-up. It may prove desirable to use a single type in more sockets. Tubes in a sizeable stock can be tested and marked as "first" or "seconds", depending upon whether they are found suitable for use in critical positions, such as in the initial stage of an amplifier, or in later stages and secondary applications.

Aside from the present necessity, reduction in the number of tube types employed will be a permanent step in the right direction. In most audio systems it would be entirely practical to use the same type of tube for all stages of amplification except the final or output stage, to which a line or resistance-termination load is connected.

Among the variations to which an average lot of small tubes is subject are hiss, microphonics, thumps, clicking and popping

in AUDIO SERVICE

In wartime, the broadcast station operating engineer must devise means for dealing with initial variations in characteristics and methods of insuring maximum life. Practical suggestions for achieving small-tube economies are given

noises, and frying or sputtering noises.

In the case of hiss, triodes are inherently quieter than tubes with more elements, substitution being desirable if the application is a stringent one with respect to noise and if some gain reduction can be tolerated. Selection is rarely practical where hiss is encountered since this usually accompanies reduced emission. A tube found in such condition initially will generally have a short period of life expectancy and should be discarded.

Selection is of definite advantage in the case of tubes with thumps, clicks or pops, since tubes having such characteristics can often be used in second or later stages where the faults are not too pronounced. Sometimes these noises occur only during the warm-up period (as much as an hour for some types) and allowance should be made for this.

Frying noises, sometimes occurring at infrequent intervals and therefore hard to locate, may indicate reduced insulation between elements. Such tubes can frequently be used effectively in circuit positions requiring less plate voltage.

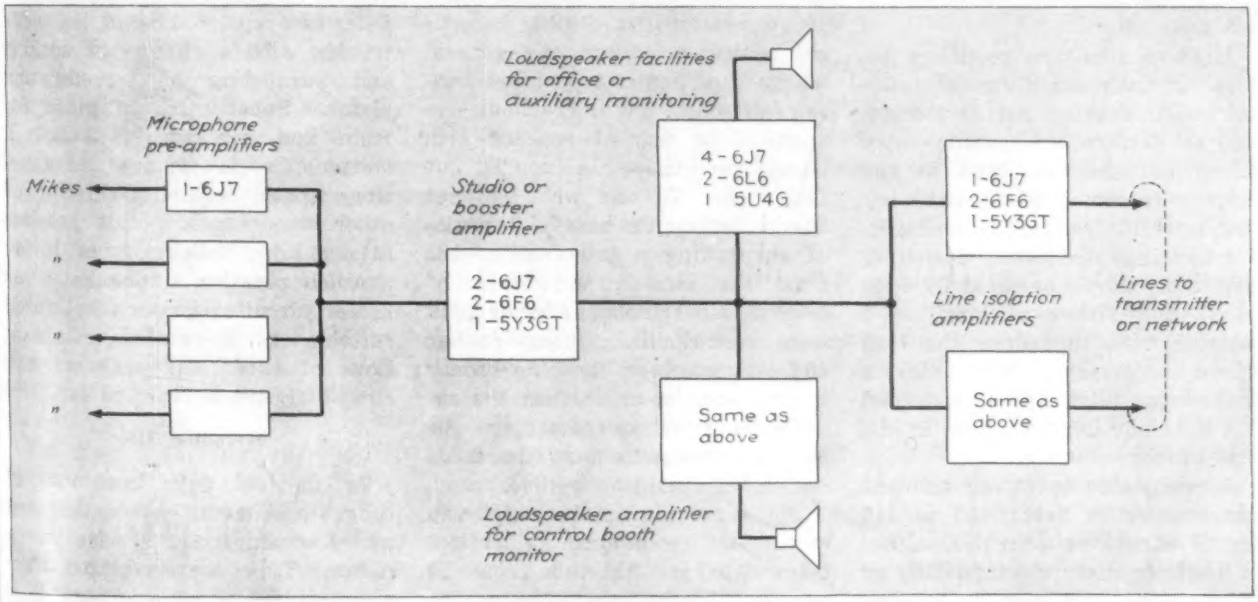
Selection is of very definite advantage in the case of microphonics as variations among tubes of similar types are usually great in this respect.

Reducing Loads

Tubes, in common with all physical devices, have limits of work capacity which, if exceeded, reduce life expectancy and may cause permanent damage. In the audio plant the output tubes of power amplifiers are frequently overloaded. Rectifier tubes are even more often abused.

Rectifiers are, in a sense, power-originating devices. They constitute a fundamental limit in a-c equipment, so that both designers and users tend to demand full and often excessive output. As new rectifier types become available the tendency is to "design up to them," so to speak, the practical result being that in much present equipment the power-supply circuits are overloaded or very nearly so.

Mercury-vapor rectifiers, having a low internal impedance, are particularly subject to excessive currents and care must be employed in choosing suitable loads. Filters having a capacitor as the first circuit element are not suitable, as competent engineers know, but there are cases where this fact has been ignored. In such cases a small inductance should be installed between the capacitor and the rectifier tube output. The value of this choke will depend upon the reduction of filtered output voltage



Typical modern broadcast station audio line-up. There are 31 tubes in this equipment but only five different tube types. Sixteen tubes of one type are used as voltage amplifiers

which can be tolerated, but even a comparatively small choke is of value in limiting maximum current peaks. Lacking a choke, a resistor of equivalent d-c value can be used, without of course the additional filtering benefits of the former. In the case of a half-wave rectifier, a choke eases the load on the tube but is of little advantage in filtering.

It should be remembered that substantial changes in power-supply output voltage will require corresponding readjustments of grid bias on the amplifier tubes involved to avoid distortion. The amplifier output will also be reduced, but there is little disadvantage in this as present-day equipment delivers power in excess of most requirements, especially to monitoring loudspeakers used in small spaces. In the case of said loudspeaker amplifiers, where they are used in secondary locations, and for other secondary amplifier equipment, a simple "brute-force" method of obtaining substantial increases in tube life consists of inserting a series resistance in the a-c line, reducing the input voltage from 10 to 15 percent. This will introduce some distortion, of course, but it is surprising how far the line voltage can be reduced while still retaining acceptable quality. Try it and see for yourself! Check quality by listening to a program, or to harmonics from an audio oscillator if distortion-measuring equipment is not available.

High-vacuum-type rectifiers, because of their much greater internal impedance, are not as susceptible to damage as mercury-vapor tubes, but they do tend to run hotter. In some types heating has been known to reduce life seriously. Tube ratings and actual operating conditions should be carefully compared and either a choke or a resistor used to reduce the load where necessary. Here also a choke-input filter will be beneficial but it is not imperative as in the case of the mercury type.

A reasonable operating ambient temperature of from 110 to 115 deg F should be provided, either by inducing natural circulation or by resorting to a blower. Cooling also reduces the danger of flash-back in mercury-vapor rectifiers. (Incidentally, while on the subject of temperature, it is well to point out that the life of electrolytic filter capacitors decreases rapidly above approximately 120 deg F and, since these are usually mounted adjacent to rectifier tubes, a double advantage is obtained by cooling. There is no practical point in operating below about 100 deg F unless transformers and other parts are potted so badly that they drip!)

Equipment Faults

Equipment faults should be carefully analyzed to determine whether tubes, or other seemingly-innocent circuit elements, are causing trouble. Many engineers refer humorously to the alleged practice of the radio servicemen who completely re-tube a receiver at the slightest provocation. Yet this very stunt was at one time, and perhaps still is, common audio maintenance practice.

Faulty operation blamed on tubes may be due to poorly-soldered or fastened wiring, high-resistance or corroded connections in coupling transformers or inductances, corrosion at tube terminals and socket contacts, and sometimes poorly-designed input circuits or inferior circuit elements which give rise to excessive thermal agitation easily mistaken for tube hiss.

Protective Devices

Various external mechanical and electrical means may be used to improve performance of tubes in critical positions. Since the general adoption of heater-type tubes having inherently low microphonic response, the use of sockets with elastic mountings has been all but forgotten. To one who has not tried it before, the beneficial results of suspending a tube and socket from the chassis by means of several stout rubber bands will seem remarkable. Sponge-rubber and even steel or phosphor-bronze springs can be used when the requirements are not too severe. All electrical connections to the floating socket should be flexible.

The foregoing applies chiefly to cases of mechanical vibration, transmitted into the tube from the chassis. If the microphonics are air-borne, i.e., purely acoustical, try damping the tube by fastening an ounce or so of lead to the envelope with spring clips. The experiment may first be tried by securing the lead mass with a rubber band. If rubber bands are unobtainable, cut strips from an old rubber glove or inner tube. In extreme conditions of air-borne noise the tube or socket can be surrounded with a lead shield (a piece of pipe with a cap over it—painted dull black inside and out to facilitate heat radiation). Extreme cases of mechanical vibration, usually of low frequency and due to building rumble, etc., can be reduced by insertion of a simple high-pass filter with a low cut-off at 60 to 80 cps. A microphonic tube can sometimes be cured by giving it a sharp snap of the finger while in operation. Presumably, this shakes into place elements which were in a loose or unstable condition.

Substitute Types

The availability of various tubes has changed since the beginning of the war and tends to vary from time to time, with certain types continuing in greater demand and thus scarcer. A check of local suppliers will indicate the immediate condition.

Tube catalogs and handbooks show a diversity of similar types, the variations being in respect to socket terminals, filament voltage, glass or metal envelope, etc. Types 6C6-6J7-57 and 6L6-807 are examples of this. Tetrodes and pentodes can replace some of the older triodes with a change of sockets and paralleling of screens and plates. Substitution of glass for metal and vice versa is usually a matter of socket change and sometimes space, requiring shifting of other components. It is possible to use lower-voltage types in 6v parallel-operating filament or heater circuits; in series circuits, suitable series-parallel combinations of tubes and resistors can almost always be worked out.

Extending Life

In the old days burn-outs of tungsten filaments were anticipated where continuity of service was a factor. Tubes were replaced after a certain period of use, regardless of whether or not they were in

(*Continued on page* 393)

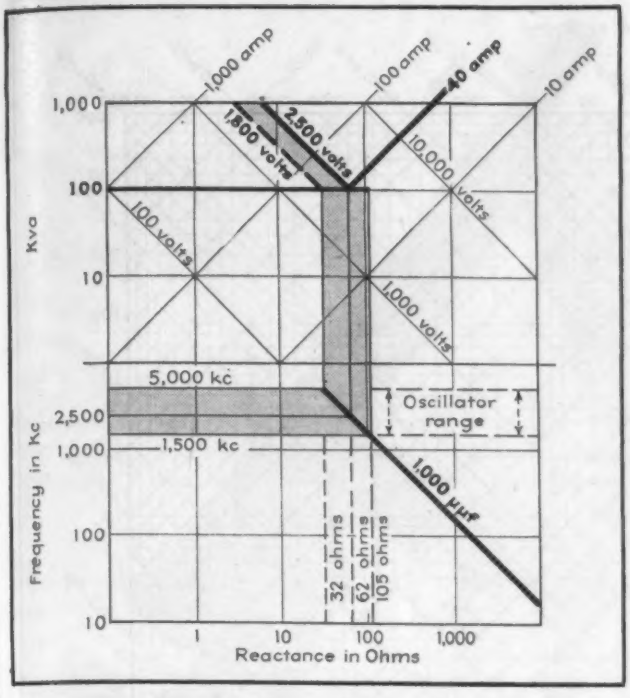


FIG. 1—Skeleton form of the chart, illustrating procedure for shifting decimal point for inductance and capacitance values, as required for the case of dielectric heating

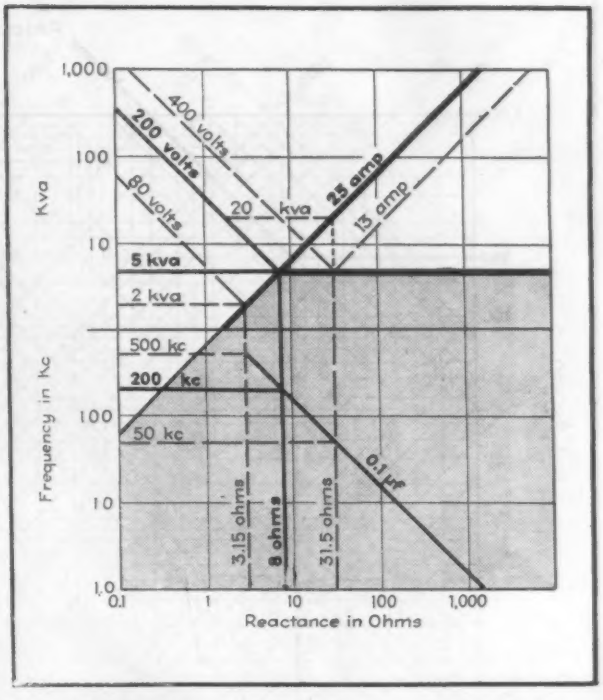


FIG. 2—Skeleton form of the chart, indicating operating boundaries of current and kva, determined by original rated conditions when an adjustment in frequency is desired

ELECTRONIC HEATING Design Chart

Choice of overall circuit constants for induction and dielectric heating applications can be made directly from the chart. Their limitations and dependencies are visualized

By C. V. FIELDS
Switchgear Engineer,
Westinghouse Elec. & Mfg. Co.
E. Pittsburgh, Penna.

DESIGNERS of induction heating, dielectric heating, and other apparatus of relatively high audio and radio-frequency power can choose appropriate circuit constants, in accordance with operating requirements, by the relations conveniently arranged in the accompanying chart. By this method such relations can be easily held within physical, electrical, and economic limitations.

The seven parameters covered by the chart are (1) current, (2) voltage, and (3) kva, correlated by the upper section; and (4) inductance, (5) capacitance, and (6) frequency, in the lower section; with (7) reactance having its scale as a common coordinate between the two sections in the construction of the chart as a whole.

The horizontal lines are ordinates of kva, in the upper section—and of frequency, in the lower section. The 45 degree diagonals are cross-coordinates of voltage and current in the upper section—and inductance and capacitance, in the lower. The vertical lines are of constant reactance, common to both sections; their values are shown along the abscissa.

There is no set order of operations in arriving at a desired solution, since any point represents a set of values for each of the four parameters, and naturally satisfies any equations involving them. It is necessary only to familiarize oneself with the directions of increase and decrease, and with the calibration of the scales so that correct interpolation may be made, to obtain a commensurate set of values.

Induction Heating

In the usual case of induction heating equipment design, three factors have been established and it is necessary only to ascertain the remaining values on the chart. The voltage and frequency are set by the power supply characteristics in the example shown on the chart;

★GUNG HO!

Each man, each machine acts as a unit . . . And every part—small and large—in every piece of equipment, performs *as one* . . . That's vital; that's what all the effort's about . . .

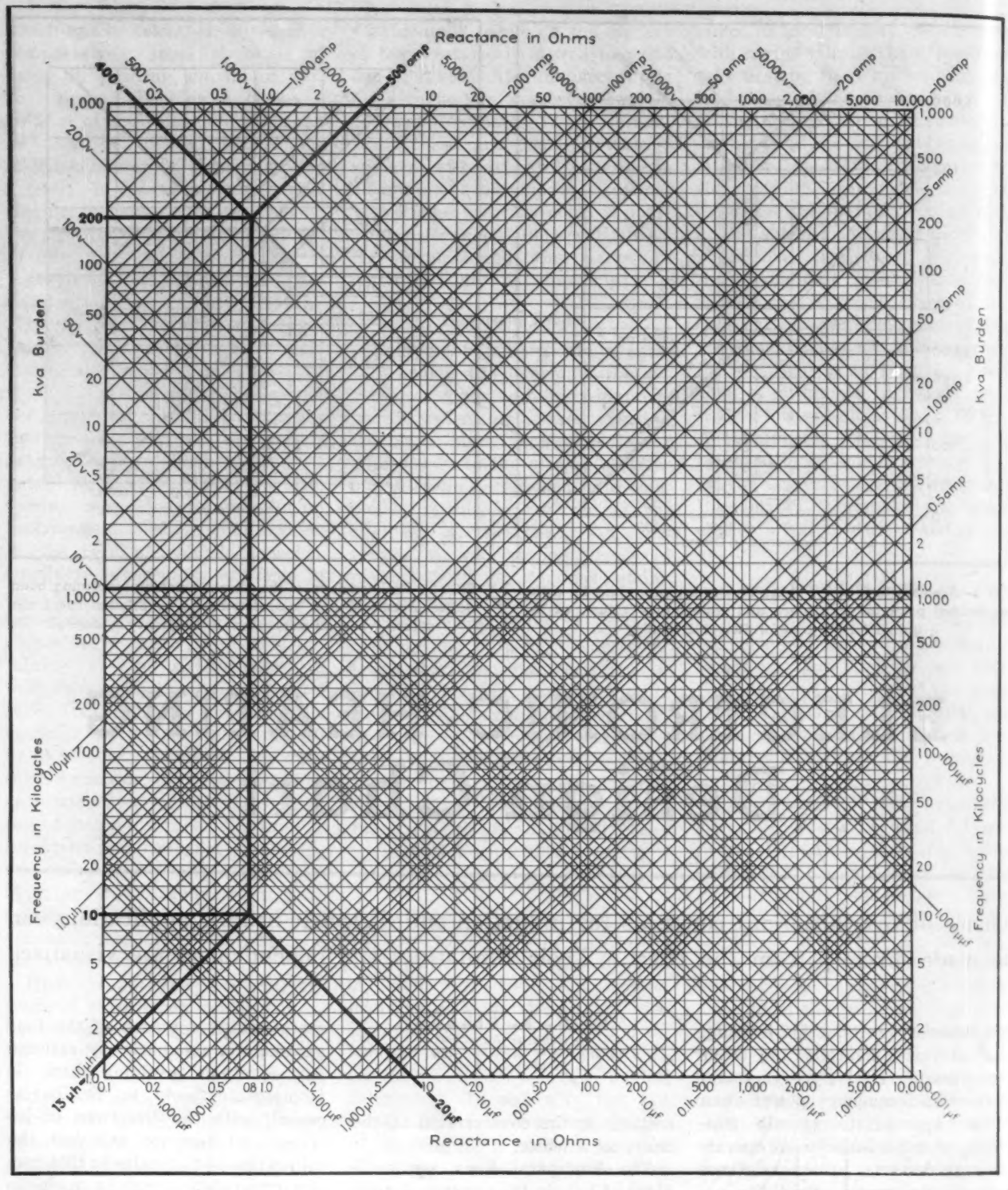
The very command: "cast off!" "contact!". . . must get through instantaneously, perfectly. And they do—because in every line of communication each CINCH part "works *GUNG* in perfect harmony *HO*."

★ *From the Universal Picture, "Gung Ho"—GUNG: Work; HO: Harmony.*

Actual Size No. 9834

CINCH Miniature Socket with "integral" or one piece shield and saddle. The high base virtually acts as a shoe horn . . . as tubes must travel a straight path when inserted or removed, thus preventing tube breakage. Full floating contacts . . . a shield base that acts as a support neutralizing vibration shock and distortion.

CINCH MANUFACTURING CORPORATION
2335 West Van Buren Street, Chicago, Illinois
SUBSIDIARY: UNITED-CARR FASTENER CORPORATION, CAMBRIDGE, MASS.



namely, 400 v and 10 kc. The current required was calculated to be 500 amperes. The intersection of the known voltage and current gives the corresponding kva (200) at the left, and the 0.8-ohms inductive or capacitive reactance is read on the abscissa directly above or below the intersection. Interpolating between the two sets of diagonal lines, where the 0.8-ohm vertical line crosses the 10-kc horizontal line, in the lower half of the chart, we find the inductance to be 13 μh and the capacitance 20 μf.

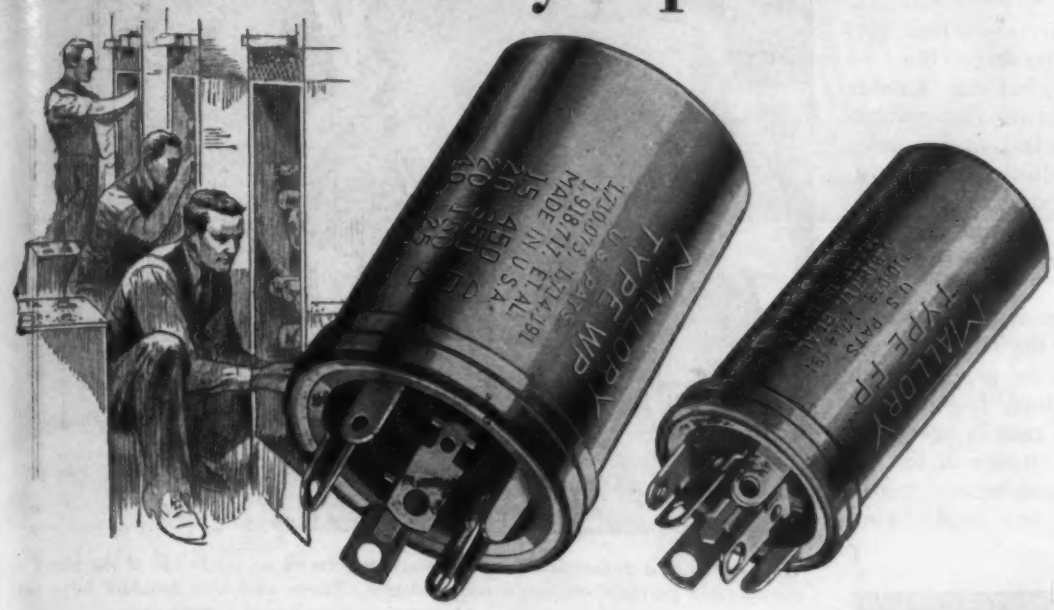
Dielectric Heating

Physical and electrical properties of specimens to be heated by the dielectric loss method establish the capacitance, power factor, and permissible voltage. From the desired temperature and rate of heating, one computes the required kilowatts, which is divided by the power factor to get the kva burden of the load. In the example shown in Fig. 1 the 1000 μf specimen requires 100 kva at a maximum of 2500 v, and the oscillator covers the 1500 to 5000 kc range.

Before proceeding to use the

(*Continued on page* 395)

Save Assembly Space and Time



LONG considered standard for metal encased units, Mallory FP and WP Capacitors are widely specified for radio and electrical assemblies. Light in weight, compact, complete with mounting features, they save assembly space and time. Mounting brackets or other accessories are not required where the chassis has been punched with the characteristic FP slotted design.

Mallory FP and WP Capacitors insure these savings:

1—Less engineering expense in capacitor applications
2—Lower costs per unit
3—Eliminate the need of special capacitors
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5—Eliminate the need of hardware for mounting
6—Uniformity eliminates the need for other parts to stabilize circuit performance
7—Encased in metal—hermetically-sealed against extremes of temperature and humidity
8—Smaller sizes simplify design and conserve chassis space

We invite you to send for complete test data and specifications.

Pioneers in capacitor research and manufacture, Mallory engineers welcome consultations on your problems. An exceptionally broad background in designing, testing and producing specialized types of capacitors and noise filters is at your disposal. Please feel free to use it. Write Mallory direct or see your nearest distributor.

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MALLORY

ELECTROLYTIC,
FILM AND PAPER
CAPACITORS

TUBES AT WORK

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Carrier Current for Railroad Communication

A CARRIER CURRENT system of communication, using the rails and wires on poles parallel to the track, has been put into operation by the Pennsylvania Railroad on the 67-mile Belvidere-Delaware branch running northward from Trenton, N. J. The system has been applied to freight service on a branch where considerable traffic is handled.

So far, equipment has been installed on 10 locomotives, 10 cabin cars and one block station. An installation at another block station is under way at Trenton, where the branch leaves the New York-Washington main line. The system permits the crews of freight trains and block operators in wayside towers to talk to one another at any time for the transmission of orders, reports, and information on matters affecting train operation. The conductor in the cabin car and the engineer in the locomotive cab may also communicate with one another and the crew of one train may talk with the crew of another train several miles distant.

The equipment operates on a push-talk system with a button provided that causes a constant audio tone to be transmitted when calling. This tone is received by the block operator and other crews on the branch, as is also the ensuing conversation. Thus, orders to one train crew are noted by other crews and a constant check may be provided on overlapping orders.

Reception of the signal from the rails is made by a pickup coil that is mounted a few inches above the track. Power for the engineer's unit comes from the headlight generator on the locomotive, while storage batteries supply the conductor's set in the cabin car. Loudspeakers are used in all positions and permit the men to hear whistle signals

The projection behind the wheel of the locomotive contains a coil for picking up the signal from the track in the carrier-current system used by the Pennsylvania Railroad

Electronic equipment for transmitting and receiving carrier-current signals at the block station, made by Union Switch and Signal Co.

A handset with a press-to-talk switch and an overhead speaker (not shown) is used by the engineer in the locomotive cab. The carrier-current equipment, mounted above the driving wheels, utilizes the tracks and adjacent wire lines for reception and transmission from train to train or to the block operator

during reception of the carrier-current signals.

Use of the carrier-current system has the advantage that no space is taken in the already crowded spectrum of radio waves used for communication purposes. Practically no radiation of the signal should take place from the wire line or the track and the signal is essentially confined to the railroad's property.

The elimination of stops at telephones alongside the tracks, to enable train crews to get in touch with block operators, has resulted in a considerable gain in operating efficiency, and no change in the operating rules governing the movement of trains has been found necessary.

Back in the caboose, a freight conductor calls the block operator for orders. He can contact other train crews or his own engineer with the carrier-current telephone system

Communications in Plane Assembly

IN RIVETING A PLANE fuselage or wing, the riveter must often direct his bucker on the opposite side of the plane wall by hammering signals on the easily marred skin covering. This is eliminated and production speeded up by the use of electronic interphones between the two men for communication.

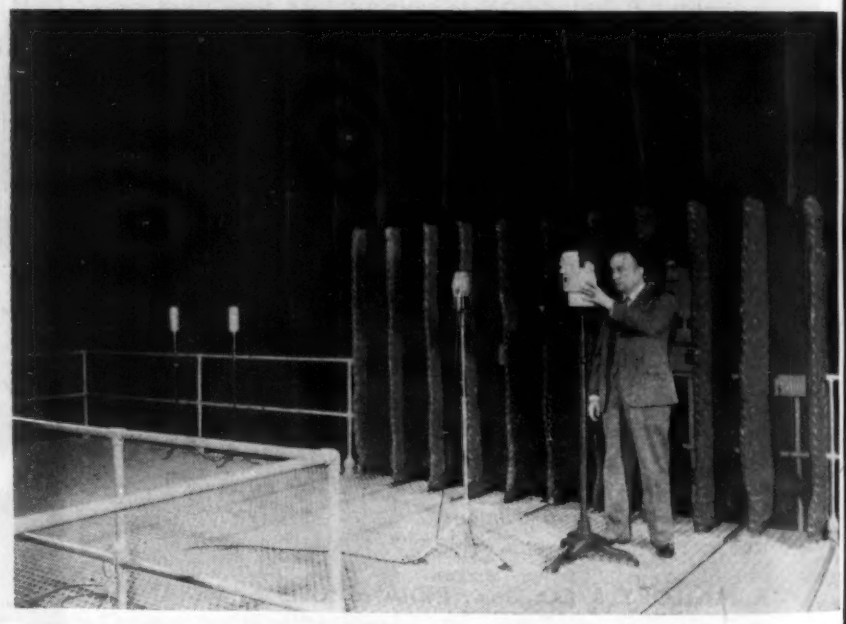
Another application for such equipment is the mating operation of large sub-assemblies where instant communication between the foreman of the mating crew and the craneman in the loft above is necessary. In this case, visual hand signals are often used although they may require relaying by several workers.

The photograph shows an electronic interphone that was originally designed for the use of student and instructor in pilot training schools and is now being used in an aircraft plant. The unit provides communication between the ground crew and workers located in various parts of large planes. Conventional or throat microphones may be used on the portable self-contained unit, which is a product of the Electronic Specialty Company of Los Angeles.

A workman in a plane plant can direct riveting crews on the inside of the plane by means of a portable electronic communicator. Bridge and ship builders have used such equipment for rapid communication between work crews

Free-Field Sound Room

A FREE-FIELD SOUND ROOM, used to obtain accurate measurements of sound for use in the development of radio and sound equipment, is contained in the RCA Laboratories at Princeton, N. J. Free-field conditions are simulated by making the room large and the absorption coefficient of the wall surfaces near unity. To accomplish this, strips of Ozite, one inch thick and spaced one



Testing the sound-reflection effects of a speaker's face and head when close to a microphone. Sheets of Ozite, one inch thick, line the room at right angles to the walls, ceiling, and floor under the platform

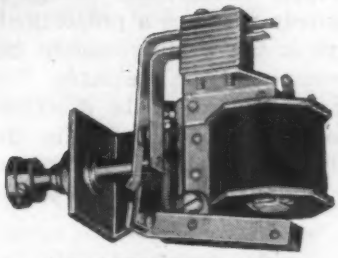
wherever a tube is used...
Electronic heaters with inductor coils connected to terminals of Oscillator Type Tubes, are used for brazing, soldering, hardening, and bonding of small diameter parts, thin sections and low resistance materials.

THERE'S A JOB FOR *Relays* BY GUARDIAN

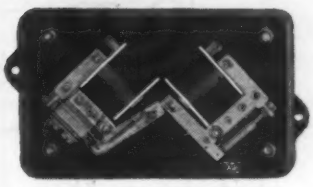
Induction heating costs less, is more dependable and easier by the electronic method. Safer, too, even with inexperienced hands, when protected from improper operation by quality relays such as the Guardian Series 90 Interlock Relay and the Series L-500 Overload Relay.

Series 90 Interlock Relay locks mechanically from an electrical impulse and unlatches or resets from another such impulse. Combinations up to DPDT available with 12½ amp. contacts rated at 110 v., 60 cycles, non-inductive load. Coil resistances up to 10,000 ohms. For AC or DC operation.

Series L-500 Overload Relay, manual reset, protects DC circuits against abnormal current surges where current conditions are constant. Contacts can take severe overloads undamaged, cannot be reset during overload. Rated for 1500 watts on 110 v., 60 cycle, non-inductive AC.



Series L-500—Overload Relay
Ask for Bulletin R-5



Series 90—Interlock Relay
Ask for Bulletin 21

Consult Guardian wherever a tube is used—*however*—Relays by Guardian are NOT limited to tube applications but may be used wherever automatic control is desired for making, breaking, or changing the characteristics of electrical circuits.

GUARDIAN ELECTRIC

1625-D W. WALNUT STREET CHICAGO 12, ILLINOIS

A COMPLETE LINE OF RELAYS SERVING AMERICAN WAR INDUSTRY

foot apart, extend into the room at right angles to the walls, ceiling, and floor. These alternate from seven to four feet in depth and are used to trap extraneous and reflected sounds.

The photograph shows the use of a robot head to test the sound reflection effects of a speaker's face and head when close to the microphone. An electronic audio oscillator is used to produce tones at various frequencies which are made to issue from a diaphragm in the robot's mouth. Tests are made on a grilled platform located 11 feet above the floor and supported by vibration-isolated feet.

Complete setup for seam welding of aircraft propellors. The current regulating compensator is the top unit at the right. The larger cabinet contains an electronic timing control

Welding Current Regulator

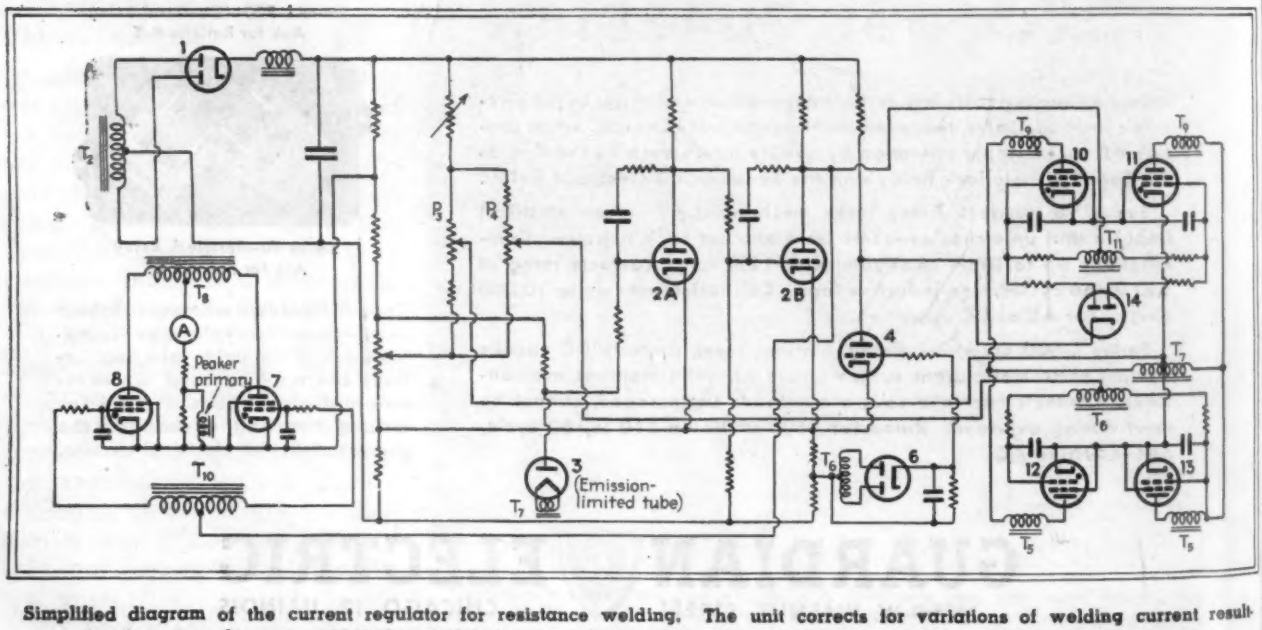
By B. Cooper

Electronics Section
Industrial Control Engineering Division
General Electric Co.

One of the most frequent causes of variation in resistance welding current is a variation in the power supply voltage during the making of the weld. Since the welding current is directly proportional to the supply voltage, any change in the supply produces a proportional change in the welding current unless compensations are made. The current regulator to be described is not designed to maintain the supply voltage at its normal level but nullifies the undesirable effects of variations in the supply voltage and permits consistent quality welding comparable with that produced on a power line having only a few percent regulation.*

Other causes of changes in the welding current are either a change in the power factor of the welding transformer and load, or a change in the impedance of the transformer and load, or a combination of these two effects. These changes may be caused by moving the electrodes of the welding machine to alter the size or shape of the sec-

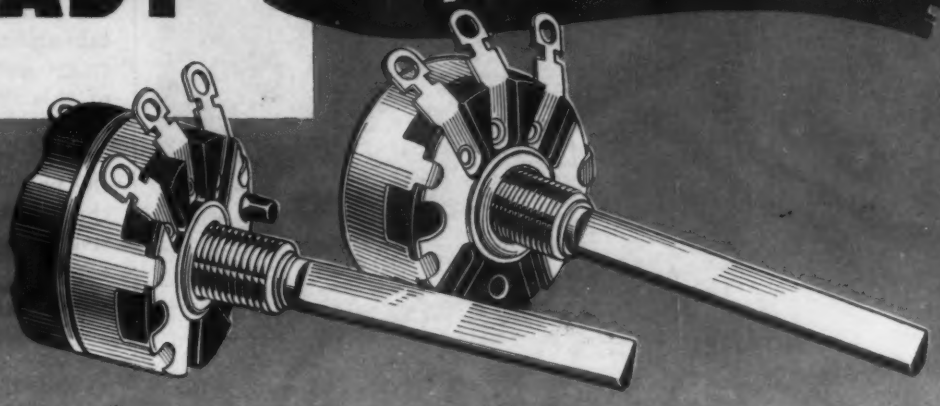
* Condensation of a paper presented before the annual meeting of the American Welding Society in October 1943, at Chicago. For purposes of consistency, the symbols employed in this article are those commonly used in communication circuits.



Simplified diagram of the current regulator for resistance welding. The unit corrects for variations of welding current resulting from impedance or power factor changes caused by the welding operation as well as supply voltage changes

IRC WILL BE READY

with WIRE WOUND POTENTIOMETERS



At war's end, IRC will be prepared to furnish ample quantities of resistors of *all types* to meet Industry's post-war needs.

That these IRC units will be available on a mass production basis is due to the fact that, in meeting war requirements, we have developed the Nation's largest resistor plant using the most improved and efficient types of specialized equipment.

ENGINEERING HELP FOR YOU

At your service on any resistance problems involved in your peacetime product design plans is our Engineering-Research staff. You may be assured that all projects discussed with this department will be held in strictest confidence.

FEATURES OF IRC WIRE WOUND POTENTIOMETERS (TYPE W)

1. *Tight uniform winding on specially processed bakelite.*
2. *Uniform contact pressure which can be adjusted to meet application requirements.*
3. *Welded resistance wire terminations.*
4. *Only one wiping contact-clock spring between center terminal and contact arm.*
5. *Designed for maximum stability under conditions of vibration and shock.*
6. *Available as duals and triples in combination with composition controls.*

PREFERRED FOR PERFORMANCE • IRC • FIXED & VARIABLE RESISTORS

INTERNATIONAL RESISTANCE CO.

401 N. Broad St. Philadelphia 8, Pa.

IRC makes more types of resistance units, in more shapes, for more applications than any other manufacturer in the world.

...the "Rose Bowl" **will be as large as the television hook-up that will telecast the game ...on a beam of electrons.**

Invisible to these millions, but essential to television, will be transformers: regulators of electronic energy ... The intimate experience gained from war communication musts, will be applied by Stancor engineers to electronic controls of the future—an incalculable plus value...Refinement in transformers spells Stancor.

STANCOR *Transformers*

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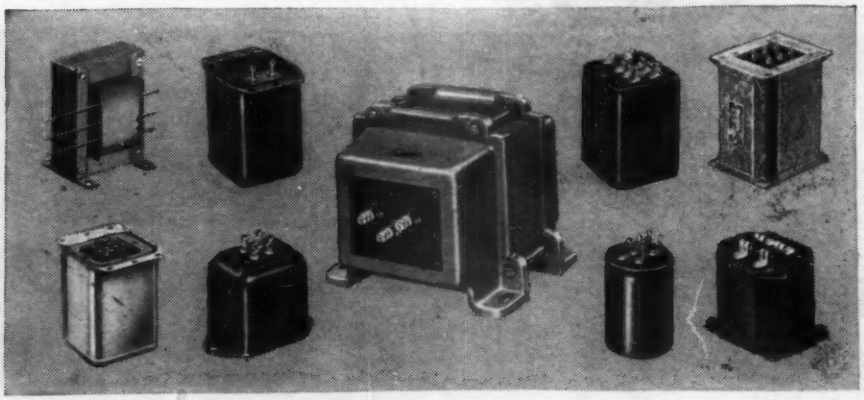
1500 NORTH HALSTED STREET - CHICAGO

Manufacturers of quality transformers, reactors, rectifiers, power packs and allied products for the electronic industries.

SEND FOR NEW COMPLETE CATALOG



ondary throat to fit a specific welding job or the introduction of magnetic material into the throat of the welder. The latter instance changes the secondary inductance and tends to make the welding load more reactive, while at the same time eddy current and hysteresis losses in the magnetic material projecting into the throat increase the effective resistance of the secondary.

A third condition exists where the welding machine is used to make welds which may alternately require a welding gun connected in parallel with the secondary of the welder. This requires a certain amount of cut-and-try juggling to get identical results. On a setup of this type the current regulator can maintain constant electrical welding conditions irrespective of the projection of material into the throat of the welder and irrespective of whether the weld is made between the main electrodes or with the welding gun.

Applications

One application of the control involved the welding of propeller blades where different amounts of steel projected into the throat of the welder at various times and caused changes in the welding current which could not be tolerated. Another application was in the making of oil and gas drums where, at one time during welding, the entire drum projected into the throat of the welder. The variation in welding current at different positions of the drum was about 40 percent before the current regulator was installed and constant manual readjustment was required. Without readjustment the drum was burned severely at one point and not even tacked together at another. The welding regulator held the welding current within 1 percent of normal throughout the range and permitted uniform welds to be obtained.

Operation

The circuit of the current regulator is shown in simplified form. The regulator consists of: first, a special tungsten filament rectifier tube which measures the rms welding current; second, a comparison and amplifying circuit for comparing this value of welding current

NOW A Miniature Thyratron With a Man-Size Rating

RCA-2D21—For Control Jobs Where Lightness and Small Size Count

STURDY construction—stable operation—high control ratio—yet this new RCA thyratron, the 2D21—is a true miniature. It weighs but ½ ounce; stands just 2⅛ inches high. And it will handle 100 milliamperes average; 500 milliamperes peak. The 2D21 is a gas-type tetrode electrically similar to the well-known RCA-2050.

In addition to its small size, RCA-2D21 has many application advantages—for example:

Low Internal Drop: Only 8 volts!

Any-position Mounting: The 2D21 is xenon-filled; no mercury to limit mounting position, or to restrict motion while in operation.

Wide Temperature Range: The 2D21 has wide temperature limits: −55 to +90°C, with little change in operating characteristics over the entire range.

Quick Heating: Anode voltage may be applied not less than 10 seconds after application of heater voltage.

Stable Operation: The inherent stability of this type of gas-filled thyratron makes greater control-circuit sensitivity possible. Low grid-anode capacitance makes the 2D21 insensitive to line-voltage surges.

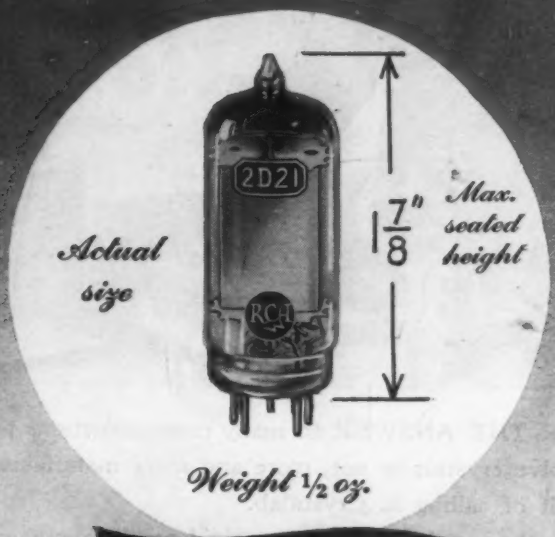
Versatility of Control: You can control the operation of the 2D21 by means of both the shield grid and the control grid. This makes for flexibility of control where needed.

Low Preconduction Current: Electrode structure provides low preconduction current right up to the start of conduction.

High Sensitivity: Grid current of this tube is very low; hence, a high resistance can be used in the grid circuit, providing high sensitivity. A high-vacuum phototube can be coupled to a 2D21 without intervening amplifier.

High Current Ratings: For periods up to 6 seconds out of 30, the 2D21 will safely carry 0.5 ampere plate current. It will carry 0.1 ampere continuously.

Need further information? RCA application engineers will be glad to help you in applying the RCA-2D21 and other RCA tubes to your design problems. Write to Commercial Engineering Section, Radio Corporation of America, Harrison, N. J.



TECHNICAL DATA

RCA - 2D21 — $3.75

Heater volts (A.C. or D.C.)	6.3
Heater ampere	0.6
Tube drop (Approx.)	8 volts
Max. overall length	2⅛ in.
Max. seated height	1⅞ in.
Bulb	T-5½
Base	Miniature Button 7-pin
Ambient Temp. Range	−55° to +90°C.

MAXIMUM RATINGS

Peak Forward Anode Volts	650
Peak Inverse Anode Volts	1300
Shield-grid Volts	-100
Control-grid Volts	-100
Peak Cathode Milliamperes	500
Average Cathode Milliamperes	100
Max. Control-grid Circuit Resistance	10 Megohms

Typical A-C operation: RMS Anode Volts, 400; Shield-grid Volts, 0; RMS Control-grid Bias Volts, 5; Control-grid Signal Volts (Peak), 5; Control-grid Circuit Resistance, 1 megohm; Anode Circuit Resistance, 2000 ohms.

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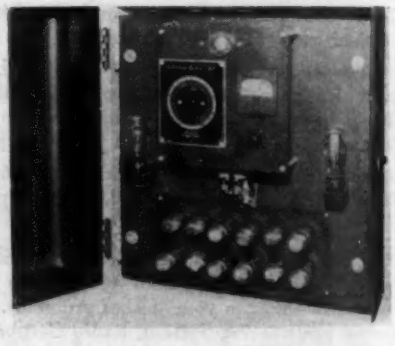
with a normal value and giving a signal proportional to any deviation from normal; and finally, a phase-shifting circuit for controlling the power ignitrons in the main welding control.

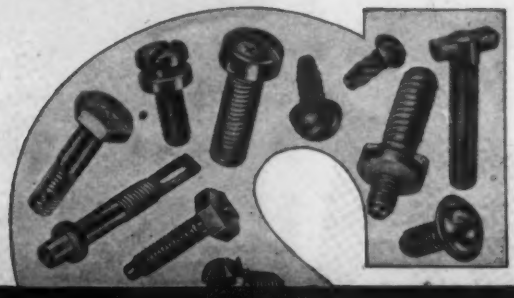
In order to hold the welding heat at a constant value, it is necessary to keep the rms value of the welding current constant. This is done by placing a current transformer in the line supplying the welding transformer and using the secondary current output to control the welding current regulator.

The heart of the regulating system is the tungsten filament rectifier, Tube 3, whose filament is heated by the current from the current transformer and whose output is proportional to this current. Since an identical facsimile of the actual welding current from the current transformer heats the filament of this rectifier tube, any variation in the heat at the weld caused by current changes will produce a like variation in the temperature of the rectifier filament. The output of this rectifier tube, which is operating in an emission-limited state, will be directly proportional to the filament temperature and to the heating value of the welding current, and will therefore, be a true measure of the rms welding current.



Control panel of the current regulator for correcting variation of resistance welding current

The output of the emission-limited tube is compared with a reference voltage appearing across part of the voltage divider on the d-c control supply. This reference or comparison voltage is held essentially constant by virtue of the voltage stabilizing action of transformer T_2, so that it will not be affected by variations in the control voltage. The difference be-



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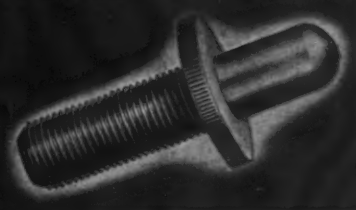

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RADIO CORPORATION OF AMERICA

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The 50 KW Transmitter of Radio Nacional, Rio de Janeiro, Brazil, shown below, is one of more than twenty-five of these 50 KW transmitters built and installed by RCA in the last two years.

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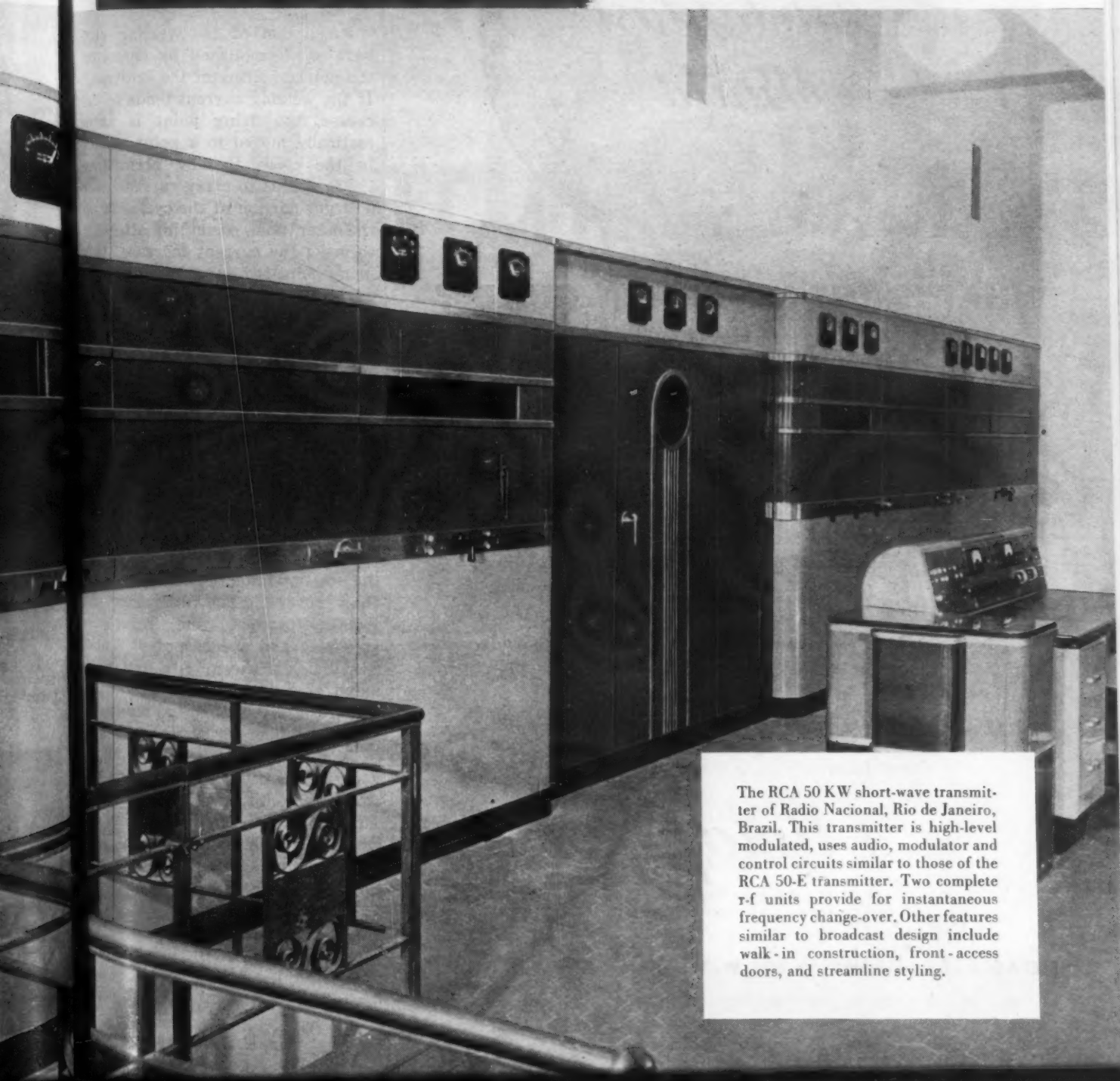

The RCA 50 KW short-wave transmitter of Radio Nacional, Rio de Janeiro, Brazil. This transmitter is high-level modulated, uses audio, modulator and control circuits similar to those of the RCA 50-E transmitter. Two complete r-f units provide for instantaneous frequency change-over. Other features similar to broadcast design include walk-in construction, front-access doors, and streamline styling.

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tween the output voltage of the emission-limited tube and the reference standard is applied to the grid of the first stage of a two-stage amplifier. The direct voltage of the two-stage amplifier is used as the d-c component in an a-c, d-c phase-shift system employing thyratron tubes 7 and 8 and transformer T_8 as a source of excitation for the peaking transformer on the main welding panel. This peaking transformer produces a peaked output voltage whose phase corresponds to the point of firing of Tubes 7 and 8. The peaked output voltage controls the firing tubes and hence controls the ignitrons.

Moving Firing Point

Regulation of the welding current is accomplished by changing the point of firing of the ignitrons. If the welding current tends to decrease, the firing point is automatically moved to a point earlier in the cycle, thereby permitting the ignitrons to carry current over a larger portion of the cycle. If on the other hand, something attempts to make the current increase, this firing point is retarded, thereby reducing the time of current conduction per cycle and decreasing the current to normal. The new firing point is chosen by the regulator so as to make the rms value of welding current constant.

Following through one regulating operation, assume that the welding current is higher than the nominal setting. Under this condition, the filament of the emission-limited rectifier, Tube 3, will be hotter than normal, and will cause the output of this tube to be greater than normal. The difference in voltage between the reference standard, and the output of Tube 3, will make the grid of the first amplifying tube more negative. The resulting action of the two-stage amplifier is that the plate of the second stage moves more negative, causing the peaker exciting tubes to be phase retarded. This in turn, retards the point at which the power ignitrons are made conducting and thereby returns the current to normal.

Regulation

Control of current by changing the point of firing is obviously limited to operation below 100 per-

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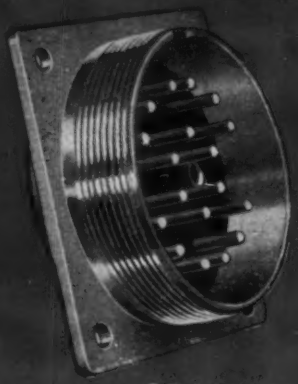

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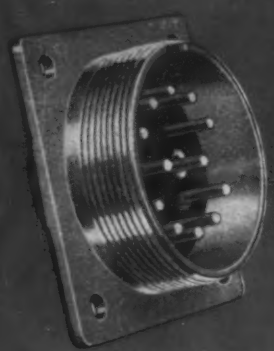

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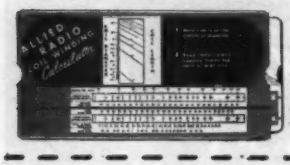

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cent or less than full sine-wave current conduction. Once full sine-wave conduction is reached, no further regulation of the weld current can be expected. At points below the full sine-wave condition, the regulator will hold the welding current to within ±2 percent of the nominal setting, for changes that would otherwise have produced a ±20 percent variation in welding current. And ±20 percent change in circuit impedance is by no means the outside limit of regulating possibilities. This regulator will hold the current essentially constant over a possible 5 to 1 change in current, having a regulating error over this range in the order of 5 percent.

Filament Switching

Since welding current does not flow continuously in the welding line, the filament of the emission-limited tube would be heated only intermittently if some other means were not provided. It is necessary to have the filament of the emission-limited tube already near its normal operating temperature in order to eliminate any appreciable thermal lag which would hinder fast and accurate control at the start of each weld.

The control provides a stand-by source of voltage to excite the filament of Tube 3 when no line current is flowing. This allows the emission-limited tube filament to be preconditioned according to the magnitude of the stand-by source of voltage. At the instant welding current does flow, the filament of Tube 3 is switched from the stand-by source to the voltage supplied by the line-current transformer.

The initial cycle of weld current will have a magnitude determined by the temperature of Tube 3 at the instant prior to the starting of the weld. By controlling and regulating the filament current prior to the start of the weld, the initial cycle of weld current may be made any value desired. By use of the tandem potentiometers P_3 and P_4 and the milliampere meter, the starting current may be easily set. Usually, it is desirable to set the first cycle to be as near as possible to the other cycle that will follow. This can be done to an accuracy of approximately 5 percent.

Since the starting cycle is set

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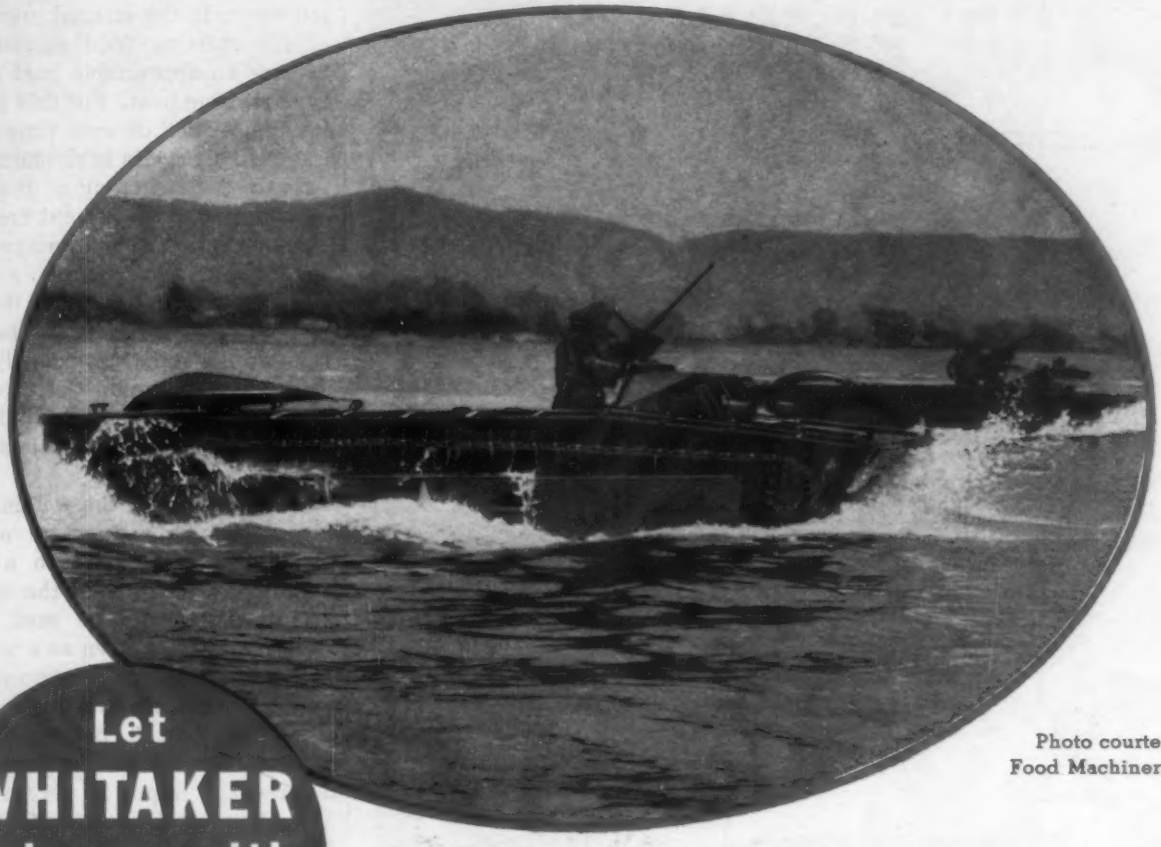

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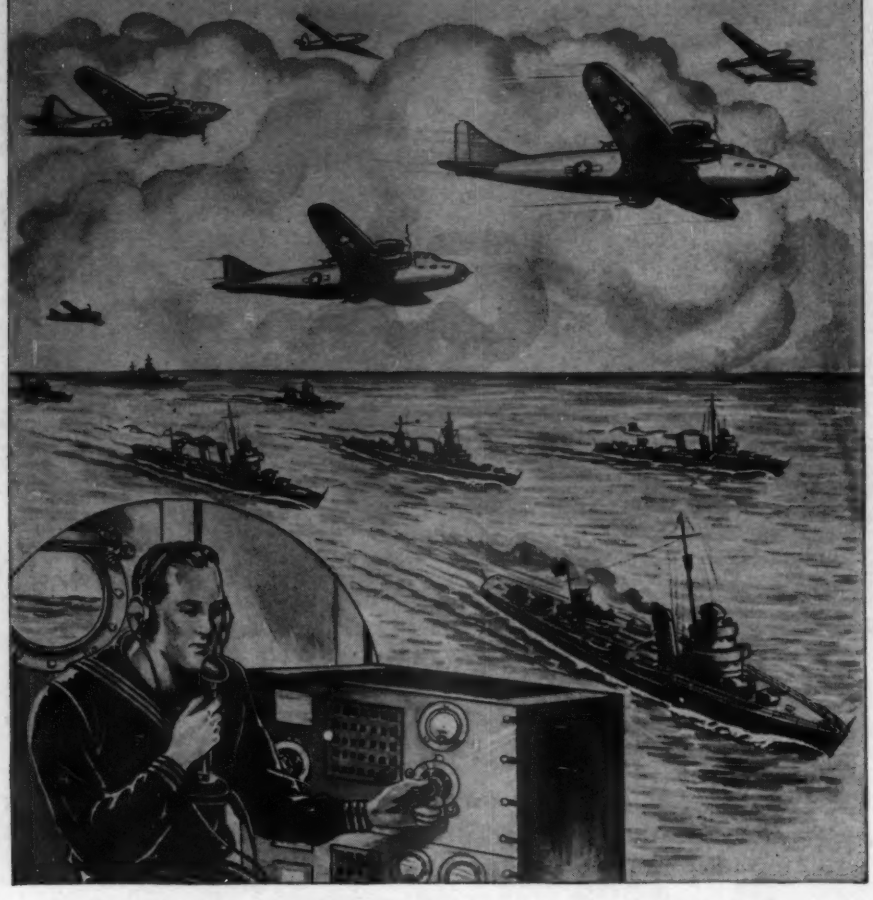

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at an arbitrary value to be approximately the same as the following cycles of welding current, it is apparent that should the duration of the welding cycle be made too short, any error in the manual presetting of the starting weld current will become an appreciable part of the total welding heat. For this reason, minimum "on" or weld time of not less than six cycles is recommended. Also, in the switching of the emission-limited tube filament from the current-transformer voltage back to the stand-by source, a small transient is introduced in the control circuit. In order to be sure this transient has completely died away, the minimum "off" or cool time during seam or pulsation welding should be not less than four cycles.

If variations in the welding current occur as a function of line voltage fluctuations, then a more simplified control than the one described here may be used. This type of control, known as a welding voltage-regulating compensator, will maintain the welding current to closer than 3 percent of the nominal current setting for a plus 5 percent to minus 25 percent voltage change. However, if variations in the welding currents occur as a result of impedance or power factor changes, in addition to possible voltage variations, then the current-regulator control described is recommended.

• • •

Electronic Control for Burning Machine

By DALLAS A. MILLER

THE CIRCUIT of an electronic control for a burning machine, used in cutting large metal plates for ships, is shown in the diagram. The unit provides an even motor speed both forward and reverse. Where a mechanical governor is used for this purpose there is a variation due to the lag of the governor, and the resultant uneven speed of the motor, although comparatively slight, slows down the burning operation.

The electronic control was applied to a burning machine that runs on tracks and burns off and trims large steel plates, some as thick as 1½ in. and as long as 30 feet. The plate is placed in proper alignment with the machine, the acetylene

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Components of the electronic device added to the burning machine for speed control. The thyratrons supply current to the motor armature while the field is energized by the small receiving-type tube

torches are lit, and the machine moves across the plate, burning as it travels. The torches can be adjusted to any angle to give the proper bevel to the cut. Thus, one side may be cut straight and the other side at a 45-deg angle.

Both sides are cut at the same time, with the torches secured a certain distance apart, to insure a uniform piece of metal. If one side were cut at a time, there would be the chance of bulge of a fraction of an inch in various places due to heat warping the plate. The even cut of the plate is important since the plate must fit the allotted portion of the ship's hull.

With the electronic unit, the variation is eliminated and the speed is so uniform that it is possible to burn 10 in. per minute where before only 5 in. could be burned. In other places where it was usual to burn 13 in. per minute it is now possible to burn 17 in. because the preheat travels at a uniform speed instead of spasmodically. The control can be adjusted to burn from ½ to 10 in. per minute, and, although designed for the Link Belt burning machine, can be used on any motor-driven equipment such as drill presses, small lathes and the like.

The same electronic system can be used to control the motor speed of a coil winder. A foot pedal is used which is in turn connected to the variable auto transformer to control the speed of winding the coil. This permits the operator to lead the wire evenly onto the various layers; if trouble occurs, he can

to End Use

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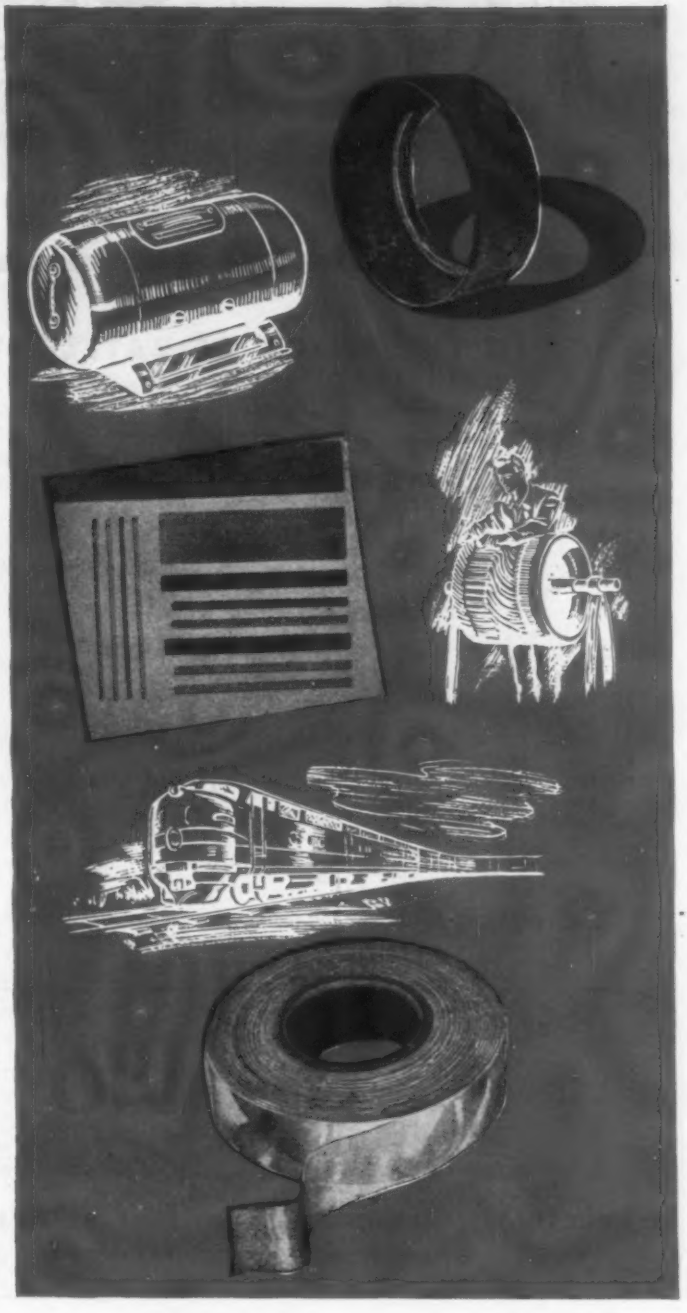

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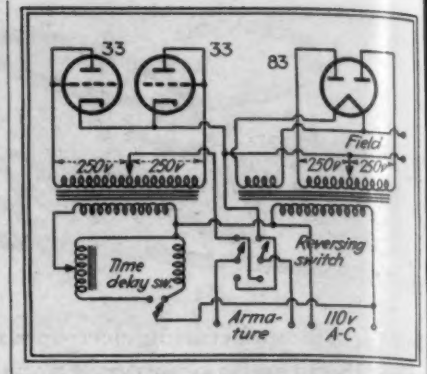

Circuit of the electronic speed control for a burning machine used in cutting steel plates. A Variac is used to change the voltage applied to the thyratron tubes

immediately stop and make the necessary corrections.

The unit may also be used for controlling the rotation of welding turntables and for testing the coils of a stator to determine the polarity of the poles. This is done by disconnecting the motor leads and connecting the two armature leads to the coils of a 3-phase motor in the customary testing sequence.

• • •

Electronic Radio Range Monitor

A NEW AUTOMATIC radio range monitor for use at airports provides instant warning if any radio course shifts as little as 3 deg from its normal setting, or fades below its normal strength. The monitor may be adjusted to operate all warning devices with a range course shift of less than 1 deg.

The course monitor receiver is located 1200 feet from the radio range station, directly on the radio course, and is connected through a telephone line to an indicator panel in the airport control room. Four receivers are required for all the four radio courses of the standard CAA four-course radio range.

So long as the radio course does not shift, the monitor receiver continuously picks up the interlocking A and N signals transmitted by the range station. If the course shifts, either the A or the N signal begins to predominate, the amount of the course shift being indicated by the comparative difference in strength between the A and the N signals. When this happens, the monitor receiver automatically transmits an electrical impulse to the moni-

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SATURATED SLEEVING

VARNISHED TUBING

This TURBO insulation sleeving copes with the wide divergency in operating conditions in present day applications. It embodies all the major essential factors responsible for above-par functional efficiency.

The ability of TURBO Saturated Sleeving and Varnished Oil Tubing, to protect circuits at all times, is corroborated by its great dielectric strength. Extreme resistance to heat is emphasized by its high flash characteristic. The imperviousness of TURBO insulation tubing to moisture, alkalis, rot, corrosion, oils and acid fumes, assures dependability under all conditions. Inside impregnation and non-projecting properties add to its long, efficient service life, while smooth bore and uniform diameter assure rapid snaking and fishing when installing. Write for free specimen board and list of standard sizes today.

WIRE IDENTIFICATION MARKERS:

● The facilitating of production and assembling operations, with corresponding increases in functional efficiency, are effected with this TURBO insulation product. Available in any size, length or color, these TURBO markers are strictly in accord with Army, Navy and A.A.F. Corps.

SAMPLE SPECIMEN BOARD: with list of standard sizes

● A request on your company letterhead will promptly bring the special TURBO Specimen Board, with necessary data pertaining to size and color. Our engineers will gladly furnish additional information regarding any of the wide range of TURBO products. You incur no obligation.

FLEXIBLE VARNISHED OIL TUBING:

● This TURBO insulation meets the diversity of requirements necessary to stand up against general break-downs, impairment through moisture absorption, and the general deteriorating influences caused by acids, alkals, etc.

EXTRUDED TUBING: resistant to sub-zero temperatures

● Where the effects of extreme low temperatures are apt to induce insulation embrittlement, TURBO Extruded Tubing is especially suited. Sudden climatic changes, wide fluctuations in temperature, or refrigerant operating conditions will not effect the dependability.

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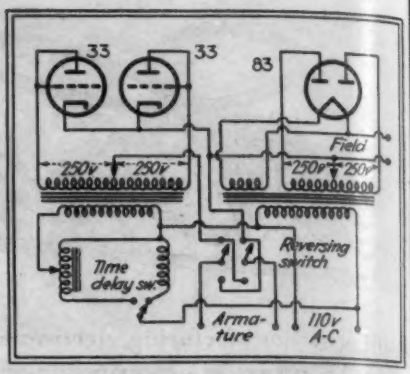

Circuit of the electronic speed control for a burning machine used in cutting steel plates. A Variac is used to change the voltage applied to the thyratron tubes

immediately stop and make the necessary corrections.

The unit may also be used for controlling the rotation of welding turntables and for testing the coils of a stator to determine the polarity of the poles. This is done by disconnecting the motor leads and connecting the two armature leads to the coils of a 3-phase motor in the customary testing sequence.

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SAMPLE SPECIMEN BOARD:
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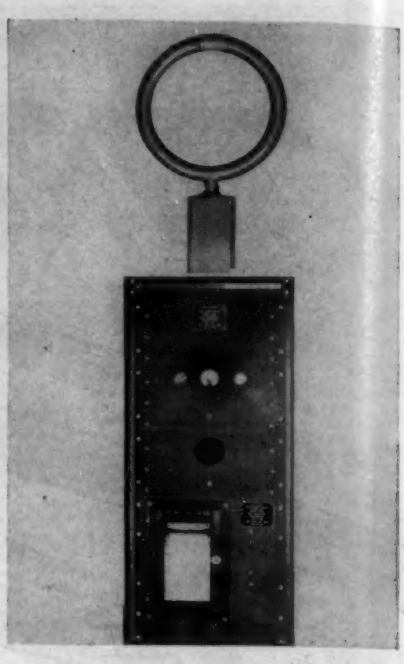

This radio range monitor constantly receives radio range signals and flashes the ground crew if changes occur in the signal. A warning signal is also sent out over the defective beacon to warn pilots

tor board at the airport, which flashes a red light and sounds a siren to warn the ground crew; at the same time, the monitor automatically dials the range transmitter which begins to send out to all pilots a warning signal at the end of each A-N cycle.

The same warning is given by the automatic monitor if the link circuit relay fails to interlock the A and N signals correctly or becomes locked; or if the output of the radio range station drops below a predetermined level; or if more than one-half of the range station identification call is not being transmitted.

Balance Circuit

To measure the comparative strength of the A and N signals, the receiver automatically divides them and feeds them into separate channels. After the two signals have been equally amplified and rectified, the resultant direct currents from the two channels are fed, in opposite phase, to a balanced bridge circuit. Should the course shift, the output of one channel becomes greater, causing the pointer of the indicating instrument on the control board to move, showing how much the course had shifted, and to which side; at the

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The terrible roar of planes over the battlefield — the friendly chatter in a studio at home . . . all these sounds are recorded with impartial fidelity on an Audiodisc. Because each blank is manufactured to precise specifications, and closely supervised every step of the way, we can give you an extra durable, better recording blank. A blank as well prepared for today's critical war events, as it will be suitable for tomorrow's abundant peacetime uses. Audio Devices, Inc., 444 Madison Ave., New York 22, N. Y.

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same time, the warning light and the siren begin to operate.

The course monitor board is located at the airport, and contains a visual indicator to show the radiation strength of the range station; a green light which remains lit so long as the station is transmitting its courses correctly; a red warning light which flashes on if anything goes wrong; a siren with a resetting switch which allows the ground crew to silence it while repairs are being made whereupon it automatically resets itself to sound a new warning; and an Angus-Esterline recorder which automatically traces a complete record of the performance of the radio range station.

Fan Marker Monitor

A similar device is used to safeguard the functioning of airway fan markers that give a pilot a definite position check along the radio range course. Both this and the course monitor are made by Islip Mfg. Corp.

The fan marker monitor receiver is located near the marker, and is connected through a telephone line with a monitor board in the airport control room. If the marker radiation strength, or its percentage of modulation, drops below a certain level, or if the marker identification signal keying becomes faulty, the red light flashes on the monitor board and the sirens are sounded. The fan marker monitor board has all the automatic features of the course monitor board. In addition, a neon light is provided which flashes with the keyed signal to provide visual check on the functioning of the fan marker.

• • •

Safety Grounding-Switch System

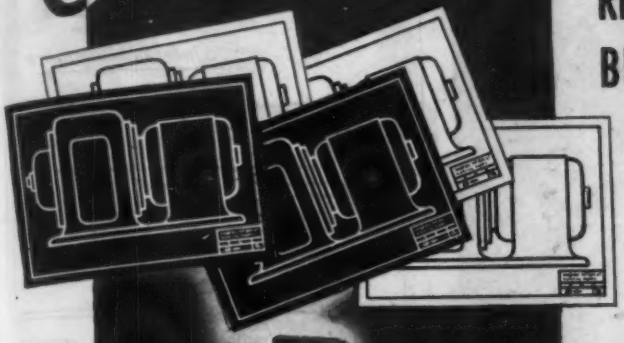
By JOSEPH ZELLE

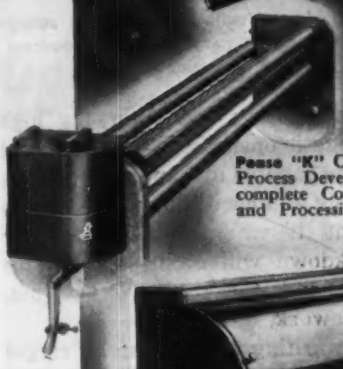
Transmitter Technician, WABC Columbia Broadcasting System

ACCIDENTAL ELECTROCUTION by a radio transmitter can be avoided by using the circuit shown at *A* in the illustration. In addition to the regular interlock system, interlock switches that close when the door is opened are connected in parallel and made to operate a relay when any door is opened. The relay, operated by the line voltage, shorts the high voltage bus to ground

Versatility

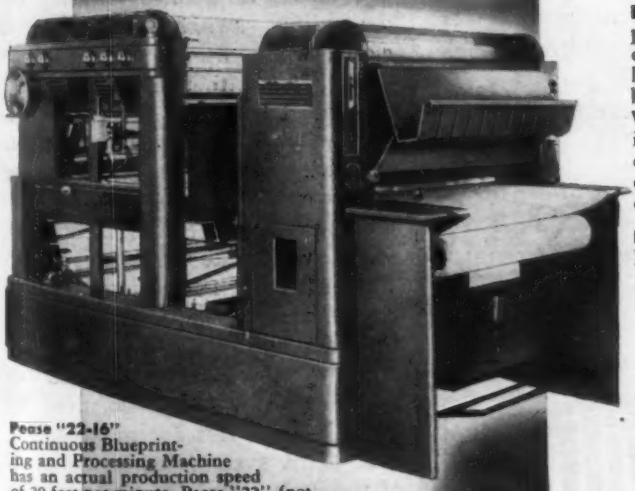
. . . MAKE ALL KINDS OF TRACING REPRODUCTIONS WITH PEASE CONTINUOUS BLUEPRINTING-PROCESSING MACHINES





Pease "K" Continuous Wet Direct Process Developing Attachment for complete Continuous Blueprinting and Processing Machines.

Pease "700" Continuous Whiteprint (Dry Direct Process) Developing Machine only.



Pease "22-16" Continuous Blueprinting and Processing Machine has an actual production speed of 20 feet per minute. Pease "22" (not illustrated) has a speed of 30 feet per minute.

BLUEPRINTS with sharp white lines and dark blue backgrounds . . . also Blueline prints with clear cut dark blue lines on clean white backgrounds are made better and faster, 30 feet per minute with Pease "22" (not shown). What is more, they are made at lower cost . . . as low as one cent (and even less) per square foot of finished prints on Pease Continuous Blueprinting and Processing Machines.

BROWNPRINTS (Negatives) and Brownline prints instead of Blueprints are made on Pease Continuous Blueprinting-Processing Machines by simply using Negative Paper and utilizing the quick change Chemical Applicator System to change from Potash to Hypo. Pease Machines are the only ones, to our knowledge, wherein Hypo is applied to both sides of the paper thus producing superior color. The prints are then dried in the continuous drier.

WHITEPRINTS (Dry Direct Process) are efficiently made by exposing Pease Multazo Whiteprint paper, or any other Dry Direct Process paper, in any Pease Printer, after which exposure the prints are developed in a separate, table style, Pease "700" Continuous Multazo Whiteprint (Dry Direct Process) Developing Machine (illustrated at left).

WET DIRECT PROCESS PRINTS are made by threading the Wet Direct Process paper through the Printer and the Pease "K" Continuous Wet Direct Process Developing Attachment (illustrated at left), which is firmly bolted to the printer and which consists of a developer tank, tray and rolls. The prints are then carried over the drier, through the wind up device which delivers them at the back of the machine.

PEASE FEATURES . . . Sliding "Vacuum-like" Contact smooths tracings, prevents errors in printing • **Three Speed Lamp Control** provides operation at 10, 15, or 20 amperes, minimizes running speed and drier heat changes • **Actinic "No-Break" Arc Lamps** burn 45 minutes without breaking arc, resume instantaneously • **Horizontal "Floating" Water Wash** floats prints free from tension, prevents wrinkles, stains, bleeding • **Quick Change Chemical Applicator System** economically allows change from Blueprints to Negatives in 30 seconds • **Eight-inch Diameter Drying Drums,** thermostatically controlled, heated by gas or electricity, dry prints "flat as hung wallpaper."

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★ WILCO Thermometals, either separately or in conjunction with WILCO Electrical Contacts, are being used with the same success for aircraft oil temperature control and in various instruments for the Army and Navy.

BOTH AVAILABLE FROM ONE SOURCE

★ The facilities of THE H. A. WILSON COMPANY permit manufacturing customers to secure both electrical contacts and thermostatic bimetal from a single source. This is important because materials from these two groups are frequently used in conjunction, as parts in the same device. The most effective use of one necessitates a knowledge of the other.

WILCO PRODUCTS ARE: *Contacts*—Silver, Platinum, Alloys, Powder Metal. *Thermostatic Metal*—High and Low Temperature with Electrical Resistance from 24 to 530 ohms per sq. mil,-ft. *Precious Metal Collector Rings* for rotating controls. *Jacketed Wire*—Silver on Steel, Copper, Invar, or other combinations requested.

WILCO sales and engineering representatives are familiar with both Electrical Contact and THERMOMETAL application. Send us your problem for analysis.

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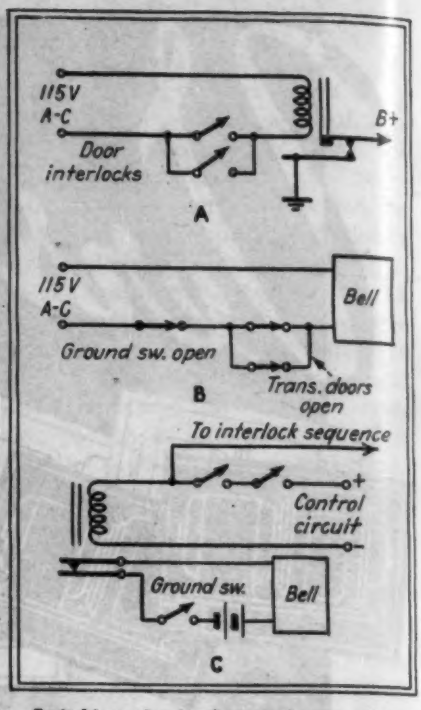

Switching circuits for maximum safety of operating personnel in broadcast stations

whenever any door carrying high voltage is opened. The relay should be one capable of handling the high voltage and care should be taken to mount it where no flashover or breakdown will occur between the relay and the high voltage bus, framework, etc.

A warning system can be rigged up as shown at *B*. Here a second interlock switch is mounted on every door and the parallel switches connected in series with a switch operated by a cam on the grounding switch bar. The secondary door interlock switch closes when the door is opened, while the grounding switch interlock is closed when the ground switch is open. Thus either the transmitter door must be closed or the grounding switch in the ground position, otherwise a circuit is completed which operates a bell, buzzer, repeating chimes, flashing lights, etc. which will "wake up" the operator. Furthermore, the line supply might be replaced by several dry cells, thus assuring operation even with all power cutoff. The dry cells can be stored in a cool place, need no attention and last for months.

A third system is shown at *C* of the figure. This system uses the original door interlocks and the control circuit voltage to operate the relay. It will be noted that the

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PRE-INSULATED

DIAMOND-GRIP SOLDERLESS TERMINALS

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INSULATION FOR
22-18

BLUE
INSULATION FOR
16-14

Perfect solderless connections — designed for mass production — with pre-insulation that saves time, labor, money!

Production cost of applying separate tubing to the terminal approximately the same as the cost of applying the terminal itself to the wire.

Only one operation — just crimp terminal on wire. Nothing else.

The insulation is bonded to the terminal and cannot be removed accidentally.

All of the features of the famous AMP Diamond Grip Insulation Support Terminal. The insulation takes the exact contour of the crimp.

Easy identification: Red insulation on terminals for wire sizes 22 to 18; Blue insulation on terminals for wire sizes 16 to 14. Press dies marked with matching color.

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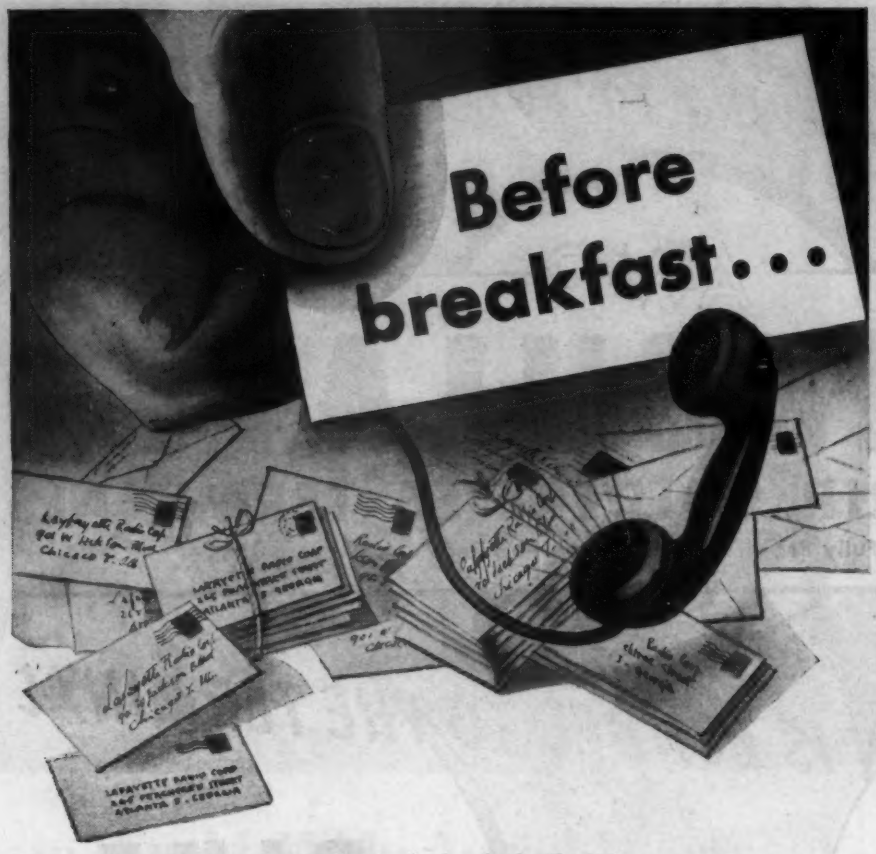

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interlock switches must come directly off the "hot" side of the control circuit so that only the transmitter doors will operate the alarm. The other side of the interlock switches continues normally to complete the control sequence.

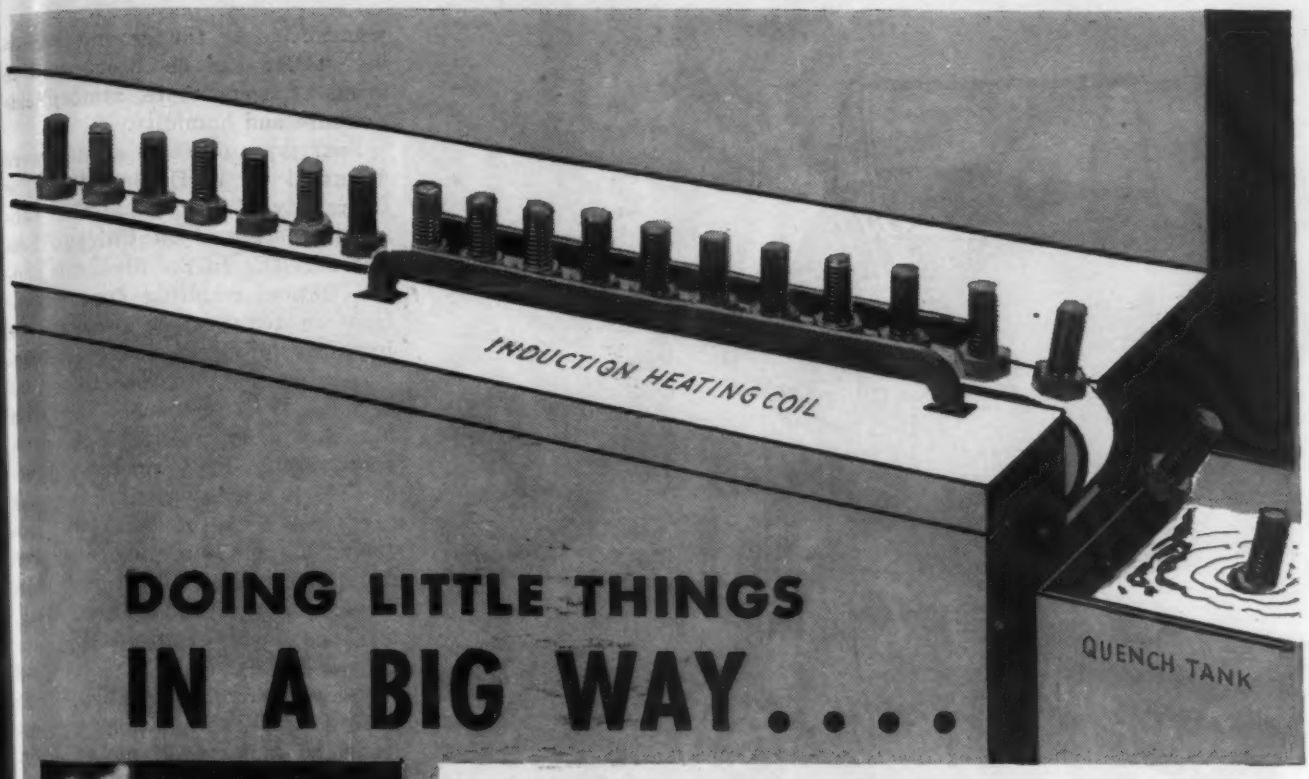
Now if the ground switch is up and a door is opened, the relay will be de-energized, the arm will fall back completing a circuit with the back contacts of the relay operating the warning bell, and/or grounding the high voltage. One disadvantage of this circuit is that with control voltage shut off and the high voltage ungrounded (as when closing down) the device will operate. This circuit is better suited to "round the clock" transmitters that are closed down only for maintenance work.

These precautions are simple to install and inexpensive but pay large dividends in saving a human life. At the WABC transmitter on Columbia Island, for instance, the grounding system prevents an operator from opening any high voltage door unless the grounding switch is in the ground position. We have likewise found it important to inspect and check periodically the continuity of the ground switch contacts. A bad contact, a warped relay arm, or bent blade is as bad as no grounding switch at all.

• • •

Electronic Heating and Radio Sondes Discussed by Chicago Engineers

RECENT DEVELOPMENTS in meteorology and weather forecasting by means of air mass analysis make it desirable to know the atmospheric temperature to 1 degree, the relative humidity to 10 percent and the atmospheric pressure to 1 millibar for altitudes up to the stratospheres. In addition, meteorologists would like to know the thickness of cloud formations, the turbulence of the atmosphere, and icing conditions as an aid to aviation. At the present time it is impossible to obtain all of this information although the first three can be obtained to a satisfactory degree of precision by means of radio sondes or balloon-borne radio transmitters. The transmitters are so constructed that the character of the signal



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Six clean, perfect, brazed joints per minute with this unit.

Carbide tool tips are brazed to shanks with better bond by high frequency heating.

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Hardening the heads of screws as they pass on a conveyor through a heating coil is only one way Ajax-Northrup electronic heating can do the little things in a big way on your production lines.

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Or if you work with small-production quantities, you'll need Ajax-Northrup's flexibility. By a simple change of jigs and coils, you can braze 1,000 parts one day, and harden 500 of another part the next day — with the same equipment. Conversion to post-war will be easy.

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transmitted to the ground receiving station can be interpreted in terms of temperature, atmospheric pressure and humidity.

Four types of radio sondes were discussed by V. E. Suomi of the University of Chicago at the February meeting of the Chicago Section of IRE. In the first, mechanical motion, resulting from variations in temperature pressure or humidity, produces a variable-frequency carrier. Another type uses a coded type of transmitter with humidity, temperature, and pressure signals in a prescribed sequence. A third type, similar to the first, makes use of a variable-frequency carrier but employs an improved method of indicating the atmospheric condition. The fourth, most commonly employed in the United States, employs a blocked or modulated oscillator in which the audio-frequency variations are interpreted in terms of meteorological characteristics.

A number of difficulties which are encountered in practice were outlined by Mr. Suomi. While temperature and pressure records can be made quite accurately, considerable difficulty is encountered in recording relative humidity. Especially at lower temperatures, even the concept of relative humidity is somewhat uncertain. Any means for producing or providing a device whose indications in relative humidity are precise and reliable would be a most useful contribution to this technique. It was also shown that the range of radio sondes could be considerably increased by employing frequency modulation in the transmitter rather than amplitude modulation.

Induction Heating

A symposium on electronic heating led by Dr. Eugene Mittelman was the second event on the program. He spoke on the desirability of matching the output of the electronic generator to the load impedance. This problem is particularly important in the electronic heating of ferromagnetic material whose magnetic characteristics change quite rapidly at the Curie temperature (in the neighborhood of about 1400 degrees). At this temperature the permeability of the magnetic material is decreased so that the impedance match which was satisfactory at low tempera-

How to get Stepless d-c Motor Speeds from an a-c Current Supply

Mot-o-Trol, developed by Westinghouse, employs the precision of electronics to provide a new, wide, *stepless* range of speed control for d-c motors from an a-c current source. It starts motors, brings them up to preset speed smoothly and rapidly. It permits wide change of speed at any time, regulates speed under varying loads, applies dynamic braking for timed stopping—and reverses the motor. Many other functions are also possible. There are no separate linestarters—no field rheostats. To get all the facts about this new packaged motor drive, write today for your copy of booklet B-3301. Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., Dept. 7-N.

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For an Audio Transformer this data would include — impedance ratio, primary and secondary load impedances, value of direct current involved in any windings, operating voltages and frequency range with degree of uniformity over entire range. In some instances it might be necessary to specify phase angle, accurate impedance in one direction or the other, perhaps insertion loss, size and type of mounting. To aid in supplying the information, especially for units approaching the limits of practicability, it would be helpful to send us a statement or sketch outlining the actual operating conditions. In designing Power Transformers or Inductors, it would be important to have similarly complete data.

In endeavoring to secure optimum transformer performance, ADC takes all of these involved factors into consideration before a single unit is approved for production.

New ADC Catalog Available!

Our new Catalog covering the specialized line of ADC Transformers, Filters, Equalizers, Key Switches, Jacks, Plugs and other electronic components is now ready. Write for ADC Catalog No. 12.

ADC

Audio Development Co.

2833 13th Ave. S., Minneapolis, Minn.

ture is no longer effective at the higher temperatures. As a result, the load is unable to absorb power at the same rate at elevated temperatures as at lower temperatures.

To overcome this defect, it is necessary to change the impedance-matching conditions when the metal under treatment reaches the Curie temperature. This is accomplished in practice by making use of the change in plate current which occurs in the oscillator tubes as this temperature is reached. This change in plate current operates a pair of relays, one of which temporarily removes plate voltage from the oscillator tubes. The other relay is used to effect the necessary coil switching for the two conditions of impedance matching. After this switch has been made, the first relay can then be used to apply power again. The entire change of switching takes place in about three milliseconds.

Dielectric Heating

Harold R. Weinmuller gave an interesting outline of some of the applications of electronic heating to dielectrics which have been made by the Commonwealth Edison Company.

Infestation in grain is frequently troublesome. By the applications of electronic heating, wheat can be raised to a temperature of 135 deg to effectively destroy bacteria without harming the wheat. Insects can also be killed by this method, even though the products may already be packaged. The use of electronic heating for the killing of bacteria shows considerable promise in the application of fruit and vegetables canned in glass jars as well as for the application in package units.

Electronic heating has been used for a number of years in the gluing of wood products, particularly when thermo-setting plastics are used as the adhesive. A 600-kw electronic heating unit operating at 1.5 megacycles has been used for a number of years in Oregon where it is employed in drying wood. It is capable of heating a stack of wood laminations 14 inches thick, 4 ft wide and 8 ft long.

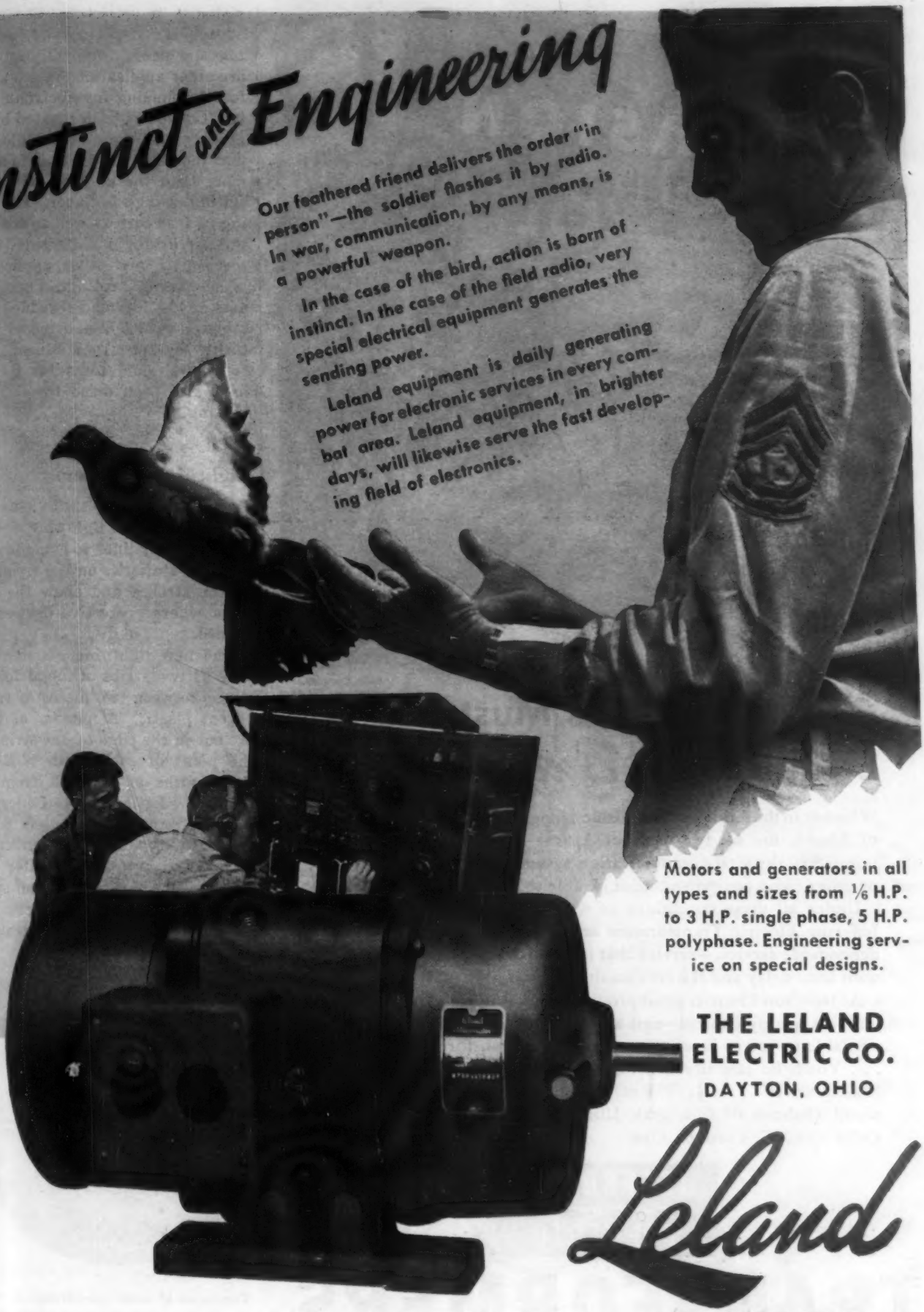
Electronic methods are also applied to the processing of wood impregnated with plastic. Such wood has high strength, is impervious to moisture, is tough and has high re-

Instinct and Engineering

Our feathered friend delivers the order "in person"—the soldier flashes it by radio. In war, communication, by any means, is a powerful weapon.

In the case of the bird, action is born of instinct. In the case of the field radio, very special electrical equipment generates the sending power.

Leland equipment is daily generating power for electronic services in every combat area. Leland equipment, in brighter days, will likewise serve the fast developing field of electronics.



Motors and generators in all types and sizes from 1/6 H.P. to 3 H.P. single phase, 5 H.P. polyphase. Engineering service on special designs.

THE LELAND ELECTRIC CO.
DAYTON, OHIO

Leland

ELECTRIC MOTORS

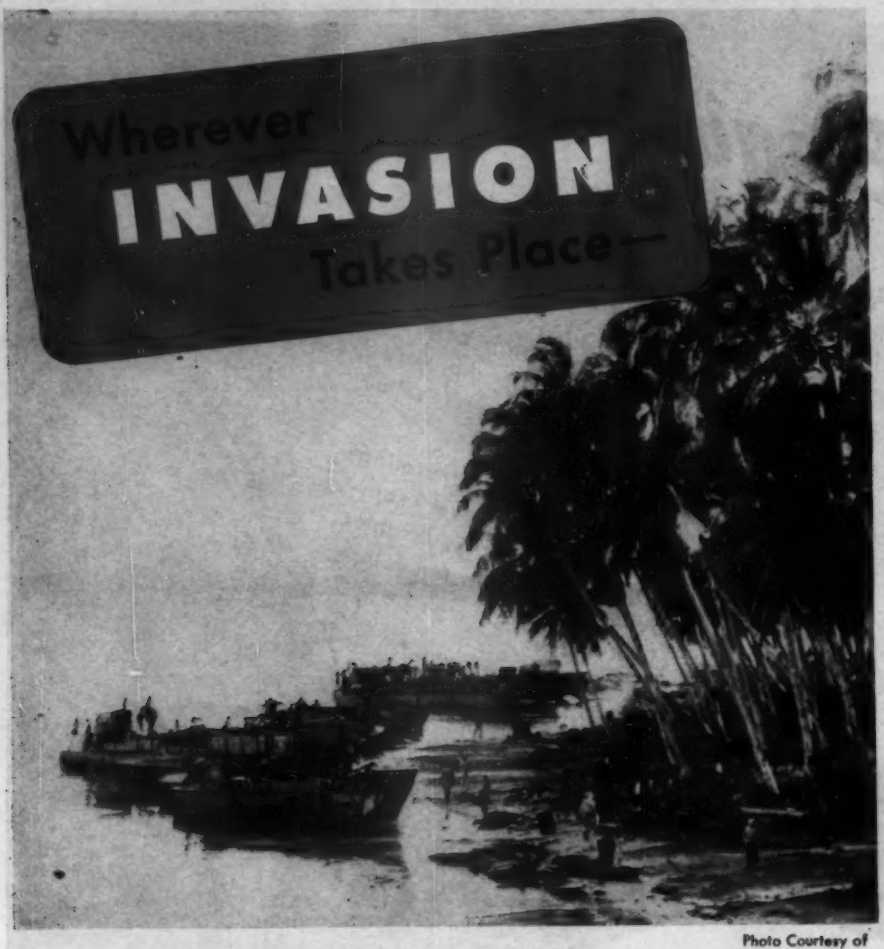


Photo Courtesy of Acme News Pictures

Communications Must Be Established—*But Quick!*

Whether in the fetid heat of the island jungles, the mist-laden shores of Alaska, the sandy wastes of Africa—the transformers incorporated in the vital communication systems, the "walkie-talkies," or other radio equipment, must be able to perform reliably.

Under all these conditions as well as on board ships at sea, Jefferson Electric Transformers are providing their traditionally dependable service,—service that is vital to victory, and to victory with least delay and fewest casualties.

At Jefferson Electric, great production facilities are coupled with uniform quality control—and an experienced engineering staff is available to you to insure the exact type of transformers required. . . . You'll be safe if you bring your problems to "Transformer Headquarters" . . . JEFFERSON ELECTRIC COMPANY, Bellwood (Suburb of Chicago), Illinois. Canadian Factory: 60-64 Osler Ave., W. Toronto, Ont.

JEFFERSON ELECTRIC

TRANSFORMERS

Radio • Television • Communication Systems • Electronics

sistance to moisture absorption. The curing of rubber and the cooking and dehydration of dry goods are other applications which appear to be promising for electronic heating. Coffee has been roasted by this process but there are indications that the inside of the bean is heated more than the surface, with a resulting change in flavor. The heating of feed corn as well as the heating and drying of table salt (if not too moist) are other applications of electronic heating. Paper cartons, rayon fiber and shredded vegetables have also been dried satisfactorily by electronic means. In foundries, sand cores for molding have also been dried by dielectric heating.

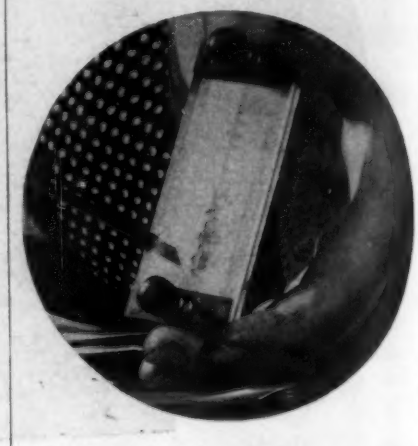
• • •

Lightning Counter

POWER COMPANY ENGINEERS can now record the lightning strokes that hit their lines to compile more accurate statistics on the frequency of the strokes and show the locations where protective devices are needed.

The new lightning counter consists of two strips of metal foil enclosed between two pieces of transparent plastic. A number of teeth are cut in the edge of one strip and the point of each tooth is a few thousandths of an inch from the straight edge of the second strip.

When lightning strikes a power line, a small part of the current is sidetracked into the counter and sent into the saw-toothed foil strip. The current must jump from the saw-toothed strip to the straight-

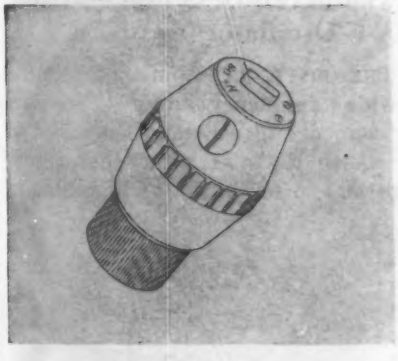


Two strips of metal foil between sheets of plastic form a counter for recording lightning strokes on power lines. Each stroke burns away a toothed section on one foil

DESIGN DATA ON PLASTICS

An Interesting Case History FROM THE DUREZ LABORATORIES

The major reason for the popularity of Durez phenolics in the electrical industry is their electrical properties, naturally. Still a second answer may be found in their rather amazing adaptability to the hundred and one problems which confront any designer. For a case in point let's go outside the electrical field.



The designers' prayers for a versatile material were answered

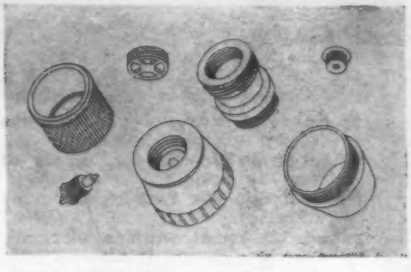
This seven-molded-part grenade and fuse called for some real designing ingenuity. And surely the designers' prayers for a versatile material were answered with the two Durez phenolics used.

The designers had to provide for fast production. Grenades are needed in enormous numbers. The moldability of Durez is a "spark plug" to speedy production. Two methods of molding were used . . . a reminder of the many advances which have been made in the faster molding of phenolics.

The designers had a worry (with a capital W) on their hands when it came to tolerances. There had to be molded-in threads, internal and external, and some very exact fits were obviously needed. Durez was the answer, with its moldability to extremely close measurements.

The designers were also up against severe service requirements. Grenades must work under all conceivable climatic conditions. Specifications were set up for a material with dimensional stability between −40° F and +170° F (there are Durez materials with heat resistance up to 450° F) and impervious to all kinds of weather. Furthermore, the material must not affect the explosive with which it is in contact. You know why!

These properties were all imparted to the same Durez phenolics which provided the desired moldability.



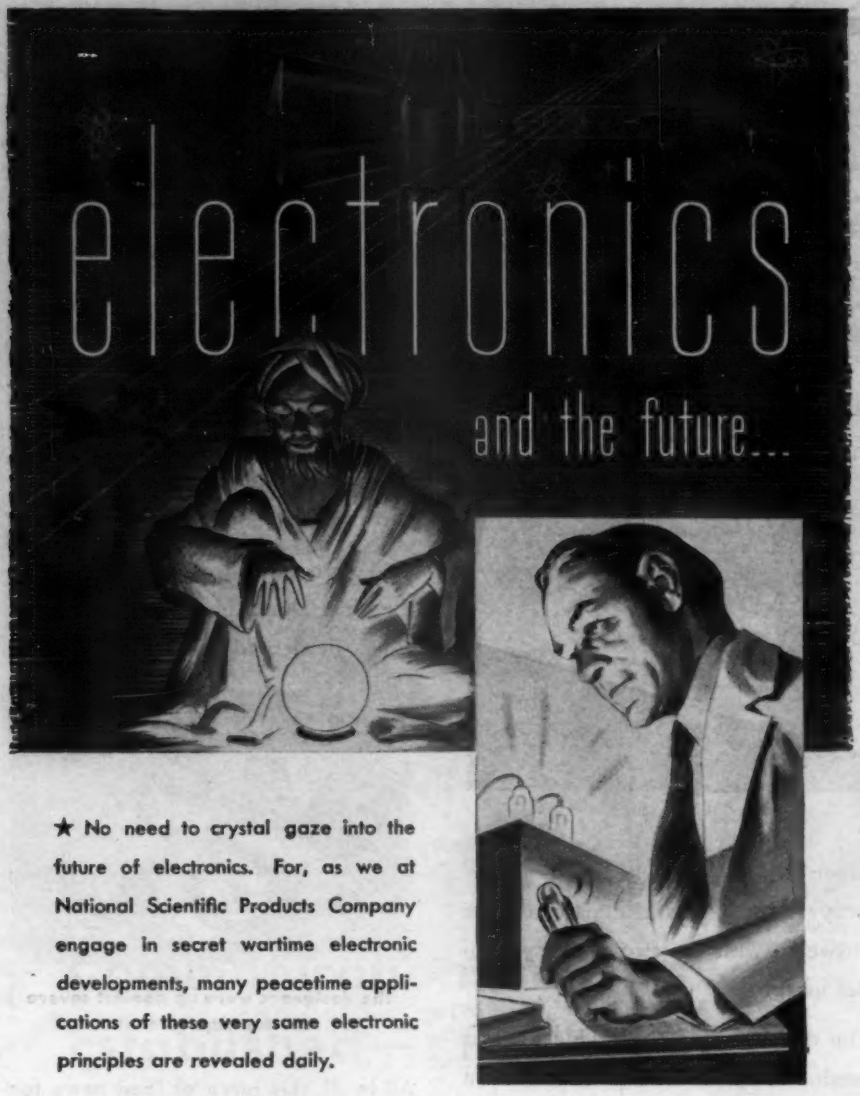
The designers were up against severe service requirements

All in all, this piece of "bad news for the super-race" gives you an idea of what can be accomplished when designer, material manufacturer and custom molder pool their talents. We welcome your inquiry on all plastic material problems and offer the facilities of one of the Plastics Industry's most experienced technical staffs in helping you work them out. Durez Plastics & Chemicals Inc., 84 Walck Road, North Tonawanda, N. Y.

DUREZ

PHENOLIC MOLDING COMPOUNDS AND RESINS

PLASTICS THAT FIT THE JOB



★ No need to crystal gaze into the future of electronics. For, as we at National Scientific Products Company engage in secret wartime electronic developments, many peacetime applications of these very same electronic principles are revealed daily.

New, cost-saving electronic designs which are applicable to post-war products ranging from radios, lighting units, thermal devices, timing and measuring instruments, electrical-therapy machines and door openers, to a host of other peacetime items, are everyday occurrences in National laboratories.

If your post-war product incorporates a tube, singly or in combination with an electrical control, or other electronic or electrical unit, we are prepared to make specific recommendations to bring it to maximum efficiency.

Write today. Your inquiry will receive prompt attention.

Electrical and Mechanical Engineering

NATIONAL SCIENTIFIC PRODUCTS COMPANY

Designers and Manufacturers of Electrical and Mechanical Devices

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edged piece of foil to get to the ground and always picks the easiest path—the tooth whose tip is closest to the straight-edged strip. As the current leaps across this gap, it makes a tiny spark which scorches a black spot on the clear plastic and burns away the tip of the tooth, so that the next discharge will choose another tooth.

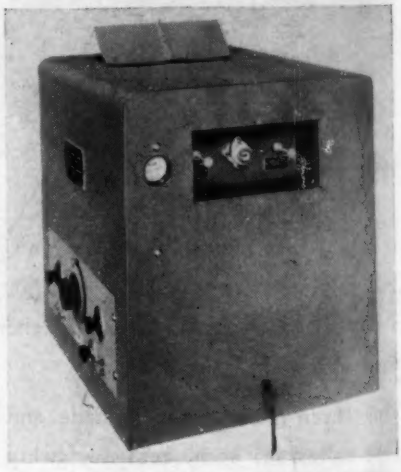
The counter never makes the error of jotting down two hits for a single thunderbolt because no two of the gaps between the two strips are ever exactly the same. Though the difference in size between two gaps may be smaller than a ten-thousandth of an inch, there is always one path which is the easiest. As soon as the spark occurs, the voltage in the strip drops and another spark will not occur until lightning strikes again.

The device is fastened near the bottom of a power line tower so the black dots burned on it can be counted in a few seconds by a lineman or an engineer. This will enable power companies to keep a record of the number of times each lightning arrester along their lines has operated. The counter was invented by Dr. Leo Finzi, a Westinghouse research engineer.

• • •

Temperature-Compensated A-F Oscillators

THE DIFFICULTIES of obtaining a wide frequency range, freedom from drift, constant output and independence of atmospheric conditions, often make it impossible to



Heater and ventilator controls are recessed in the side of the cabinet on the a-f standard oscillator. The thermometer shows the operating temperature

Take a Good Look at THE SCREW

THAT'S "GEARED TO THE KEY"

Bristol Multiple-Spline Socket Set Screws set tighter . . . even in hard-to-reach places . . . without rounding out or breaking.

Where a small screw is called for . . . where vibration will be a problem . . . where the fastening point is at an awkward place — think immediately of the *screw that's built like a gear.*

The Bristo Multiple-Spline Socket Set Screw is specified for aircraft parts, photographic equipment, electrical assemblies, because the multiple-spline design (the teeth in socket are geared to the key) provides much greater strength, permitting more tightening force even on screws as small as No. 4 wire size! The diagram shows why.

Hex: Key exerts *outward* pressure against socket wall; screw will round out or break.

Bristo: Key exerts *inward* pressure; no danger of rounding out or breaking socket wall.

So Bristo Multiple-Spline Screws can be set tight to hold against vibration, yet they can be loosened with a flick of the key! See THOMAS' REGISTER for more facts, list of product applications.

Here's What You Get from the Screw that is Geared to the Key

1. Easier transmission of rotary wrenching power; hence faster assembly.
2. Tight "meshing" with the spline-shaped key; hence no key slippage.
3. No rounding out or breaking socket wall; turning key does not spread the screw.
4. Quick removal — the gear principle acting to release the screw's strong hold.

BRISTO "MULTIPLE-SPLINE" SOCKET SET **SCREWS**®

Geared to the Key — for faster, easier, tighter setting

The BRISTOL Company
MILL SUPPLY DIVISION

FOR Low Thermal Conductivity USE

CHACE

Manganese

ALLOY

No. 772

This new alloy is being used by circuit breaker manufacturers to build brackets for supporting bimetal elements where loss of heat would otherwise upset desired action . . . may also be used by makers of domestic irons and other appliances where supporting members made of this alloy will serve as a heat barrier to keep handles cool . . . note the following comparative conductivity values:

Silver	100%
Copper	93%
Aluminum	54%
Iron	16%
Nickel	15%
Monel	6%
Chace No. 772 Alloy	2%

Chace Manganese Alloy No. 772 also possesses . . . high electrical resistivity properties, about 60% higher than most alloys now in common use . . . high temperature coefficient of expansion, twice that of ordinary steel . . . high vibration damping constant, about 25 times greater than steel . . . it can be machined, stamped, drawn, extruded, and welded to itself or steel . . . now available in sheets, strips, rods and special shapes.

Complete engineering and research facilities available . . . "Bulletin No. A-942" giving detailed information regarding Chace Manganese Alloy No. 772 sent on request.

W.M. CHACE CO.

Manufacturers of

Thermostatic Bimetals and Special Alloys

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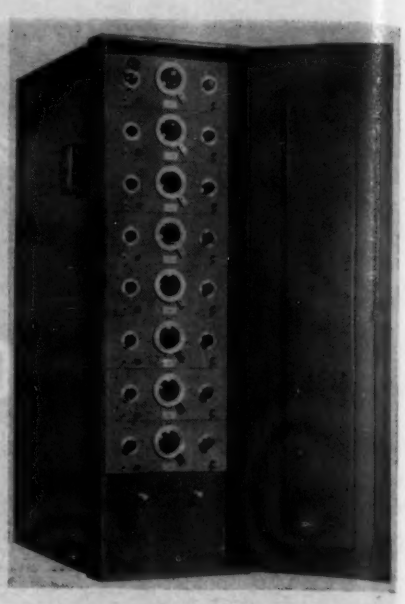

Eight temperature-compensated a-f oscillators in one cabinet provide a convenient source of separate frequencies for production testing of low-frequency units

adapt wide-range audio frequency oscillators to precision measurements. A solution to this problem has been achieved by the Electro Products Labs. of Chicago by providing constant temperature control for an R-C negative feedback type of oscillator.

This type of oscillator can be designed to provide a frequency ratio range of at least 10 to 1 by varying the capacitance of the frequency-determining circuit. Use of an amplifier stage with a considerable amount of feedback provides considerable stability but the oscillator is still subject to frequency variation as a result of changes in temperature.

As a means of overcoming this difficulty, the oscillator has been enclosed in a temperature controlled chamber so designed that operating temperature is always somewhat greater than room temperature.

Eight temperature controlled oscillators have been built up into a single unit for the Thordarson Electric Mfg. Co. of Chicago where it is used to provide eight separate frequencies simultaneously for laboratory and production testing. It is reported that the audio oscillators maintain their frequency precision within one cycle over long periods of time, as determined against a check with a primary frequency standard.

IT WILL SOON BE ANOTHER DAY

The lush days of "Cost Plus" that have placed so little emphasis on production economy will disappear when "C-Day" arrives. Conversion to civilian goods will again place a premium on efficiency that springs from a cost "know-how." But cost-sensitive production comes only of long experience. It is not born of wartime . . . it is a stranger to war production.

Peace-time manufacture survives only as it demonstrates the principles of profit-and-loss accounting. There is no room for carelessness, or laxity, or indifference to costs.

Lewyt is *not* a war baby. Lewyt is a "manufacturer's manufacturer" with 56 years of cost-conscious "know-how". It returns to peace-time contract manufacturing with long experience in meeting the needs of production engineers who will have only costs and efficiency in mind.

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USE A MANUFACTURER'S MANUFACTURER . . . . .

● ***One Contract—One Responsibility—One Cost***

Lewyt's business is Contract Manufacturing. We specialize in electric and electronic instruments, chassis and housings; mechanical and electrical assemblies; highest precision machine work; sheet metal fabrications; all types of welding, product finishing, etc.

We also provide advanced engineering facilities as service assistance to our clients in connection with the design and re-design of their products under development.

Write on your business stationery for 48-page book, "Let Lewyt Do It" . . . the story of the Lewyt Organization told in pictures.

Lewyt

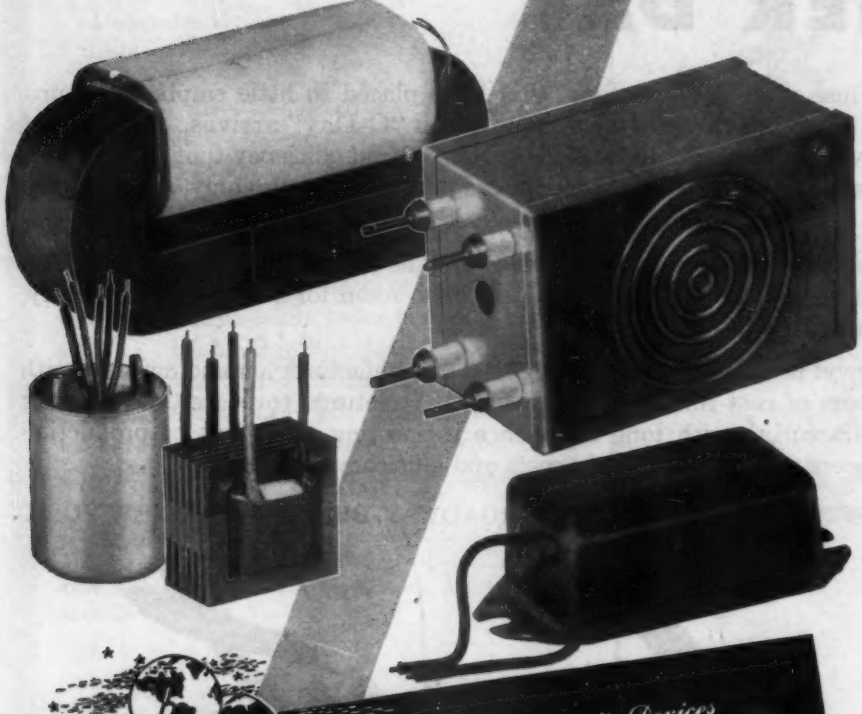
LET LEWYT DO IT

BUY MORE WAR BONDS

SMALL and MEDIUM
TRANSFORMERS
for QUICK delivery

If you have the proper priority rating, Consolidated Radio can now make deliveries in a few weeks instead of many months!

Consolidated Radio Products Company has recently greatly expanded its production facilities on a wide range of small and medium transformers including Pulse Transformers, Solenoid Coils, Search Coils. Other products include Range Filters, Headsets.



Electronic and Magnetic Devices
CONSOLIDATED RADIO
Products Company
350 W. ERIE ST., CHICAGO, ILL.

Railroad Radio

(*Continued from page 95*)

radio repeater equipment with associated antennas which provide considerable directivity and reinforcement of signals at various points along extended railway routes.

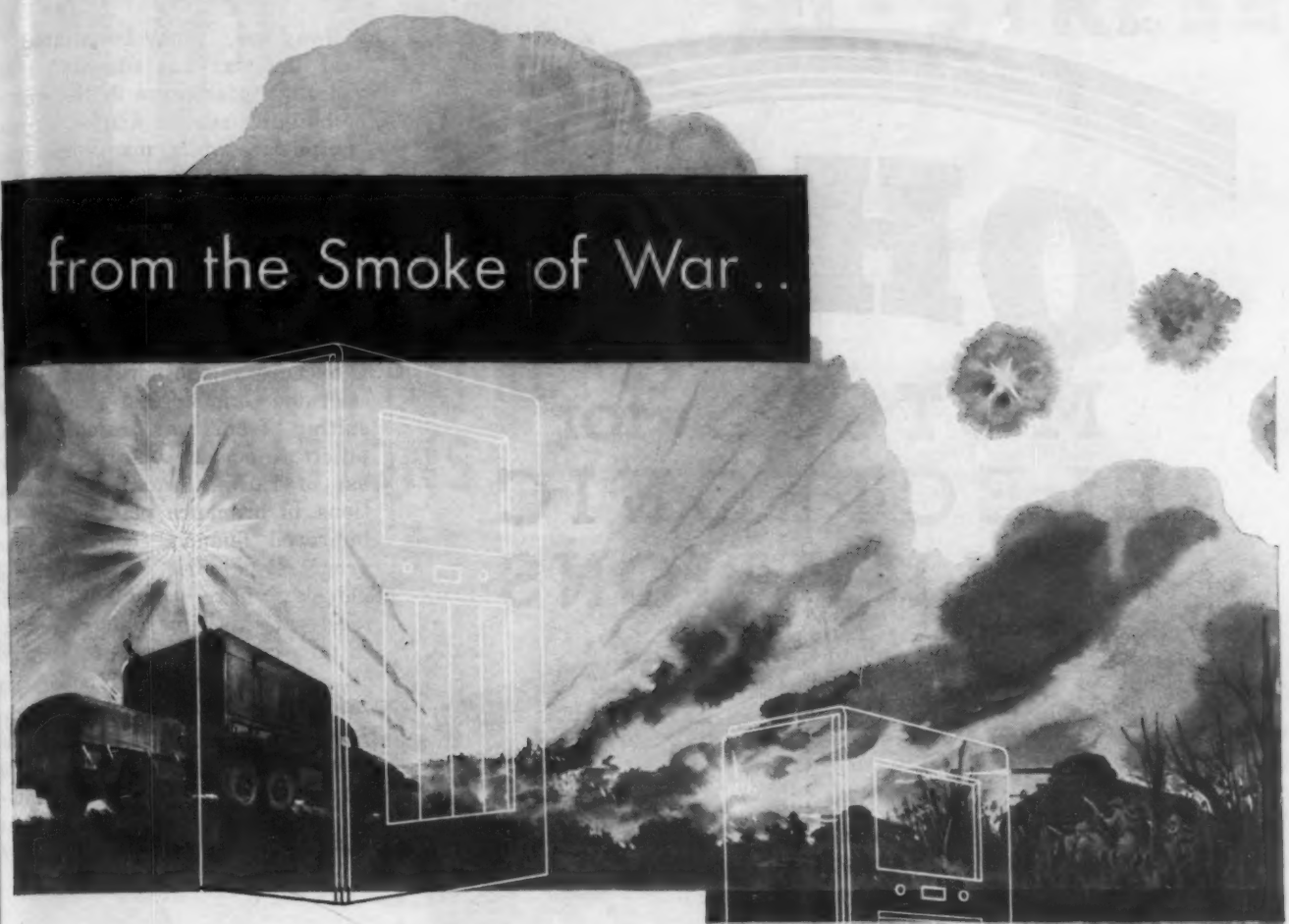
In this regard, it should be stressed that the problems involved in the design of radio equipment for use by the railroad industry differ considerably from those associated with the development of radio apparatus employed in other forms of transport communications. Not only must such equipment meet the specific technical and operational requirements of railroad service, but the installation of equipment on locomotives must comply with the safety requirements of the Interstate Commerce Commission.

Special Equipment Needed

It is believed by radio engineers intimately acquainted with railroad problems that no simple adaptation of present-day, two-way automobile or military radio equipment will meet satisfactorily the various requirements of the railways. Equipment must stand the violent shock and multi-directional vibration peculiar to locomotive operation. Apparatus must be housed and constructed in such manner as to withstand the effects of smoke and corrosive gases emanating from steam locomotives. The equipment must also be mounted and housed in such manner as to be replaceable with maximum speed in order to avoid delaying the scheduled operations of locomotives in the event of failure of radio components. Further, the electrical design of the equipment must be such that it will operate on existing power-supply sources employed on various types of locomotives. Inasmuch as primary power supply voltages on different locomotives normally range from 32 to 110 volts d.c., radio equipment must be adaptable for use over a wide range of operating voltages.

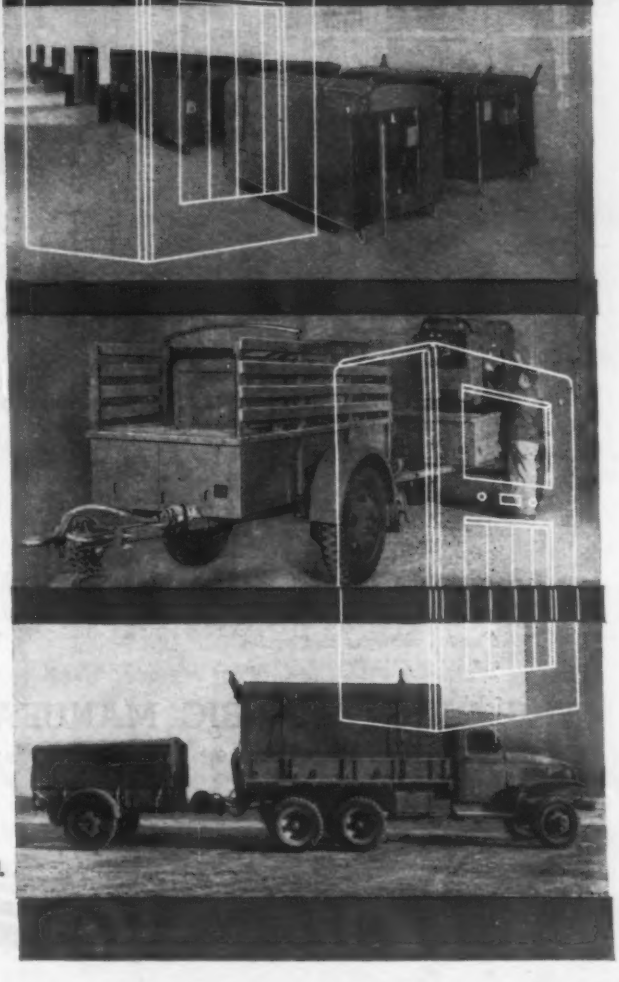
In considering the problems related to shock-mounting and design of transmitters and receivers for

from the Smoke of War . .



finer Radios for Peace

War's demands for better weapons have added mightily to the progress of radio. Here at Detrola we are in the forefront of it. Detrola engineers are giving their knowledge and experience to the perfection of new and finer electronic equipment. Detrola production workers are learning and employing new short cuts in the mass manufacture of quality products. Our work today is providing us with ideas for a great variety of postwar radio-electronic devices . . . and new ability to translate them into products of finest quality. *Every War Bond You Buy Helps Bring Victory Closer. Buy Another Today.*



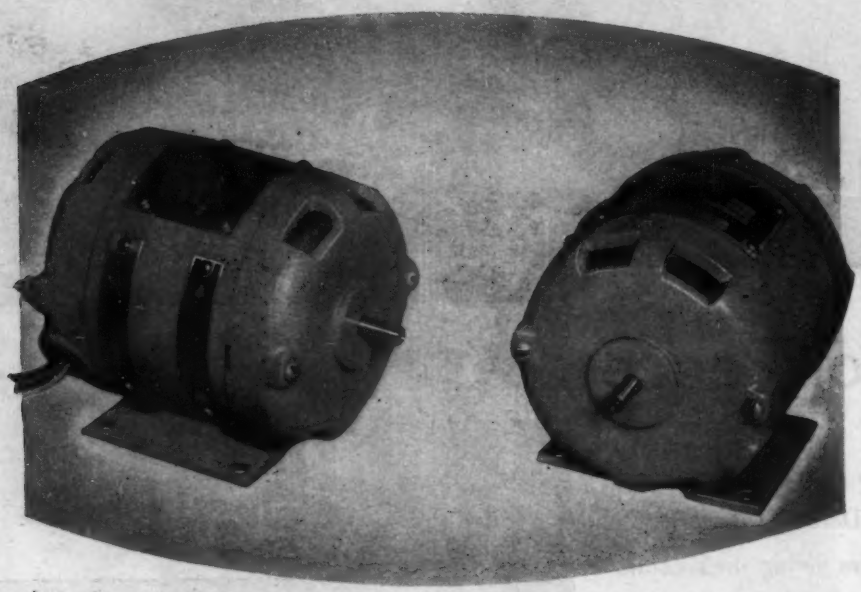
DETROLA RADIO

DIVISION OF INTERNATIONAL DETROLA CORPORATION • BEARD AT CHATFIELD, DETROIT 9, MICH.

C. RUSSELL FELDMANN dr PRESIDENT

OHIO

MOTORS for ELECTRONIC APPLICATIONS



1/75 HP—115 V-60 Cy.—1 Ph. 1670 R. P. M.—Clockwise, Ball Bearing, Ventilated.

●

Cut shows one of many types and sizes of Ohio Motors designed for driving Electronic Devices.

RANGE

1/100 to 2 HP.—A.C.
1/100 to 1 HP.—D.C.
1/100 to ¼ HP.—A.C. Synchronous.
1 to 100 oz. ft. A.C. Torque.
Shell type motors for built-in applications to 4 HP.—D.C. and to 7½ HP.—A.C.
All usual voltages and cycles.

What is your problem?

THE OHIO ELECTRIC MANUFACTURING CO.
5908 Maurice Avenue Cleveland 4, Ohio

railway use, it may be pointed out that the war has educated many radio manufacturers in the matter of building rugged and shockproof equipment, while many improved types of tubes, power-supply units and other component parts, possessing the necessary durability for sustained railroad use, have been developed.

In summarizing the state of the new railway communications art, it is encouraging to note that the accelerated technological progress resulting from war research, the practical benefits afforded by the use of railway radio communications in ordnance plants, and the improved financial condition and progressive spirit of the railroad industry have combined fortuitously at this time and should facilitate rapid growth of this new field. On the continued cooperation of the railroads, unions, governmental agencies and groups in the radio field is required in order to create an important postwar industry which will provide new services and employment opportunities for many men and women.

• • •

ELECTRONICS AT KISKA

An electronic megaphone in use by American-Canadian forces while advancing inland during the occupation of Kiska. The equipment consists of a University IB-8 reflex speaker, fed by a Bogen amplifier and American microphone. Official U.S. Navy photograph

NOW "HI-STRESS"* Speed Nuts [PATENTED]

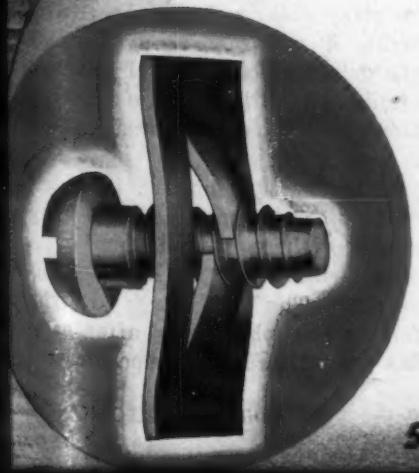
For

HIGH TEMPERATURE APPLICATIONS

in all Structures

• The new "Hi-Stress" SPEED NUT conforms to AAF specification No. 25531 and has been granted engineering approval by the Army Air Forces. It is interchangeable with nut plate AN362, for high temperature applications in all structures.

This new SPEED NUT is a lighter weight, one-piece integral unit. Because of its unusually low installation torque, it allows more rapid insertion of bolts or screws. Even after many removals under service conditions, this new SPEED NUT still retains its self-locking torque. Identify by SPEED NUT No. A6103H-1032.



TINNERMAN PRODUCTS, INC.
2106 FULTON ROAD CLEVELAND 13, OHIO

In Canada: Wallace Barnes Co., Ltd., Hamilton, Ontario
In England: Simmonds Aerocessories, Ltd., London

* TRADE MARK REG. U. S. Patent Office

SPEED NUTS - THE FASTEST THING IN FASTENINGS!

THE ELECTRON ART

Polarized Light Servo-System for Integration.....216
Photo Tube for Biological Recording.....230
Simple C-R Tube Voltmeter.....234
Converting Coordinates with a Mannheim Rule.....244
Electron Gun for X-Ray Tube.....248

Polarized Light Servo-System for Integration

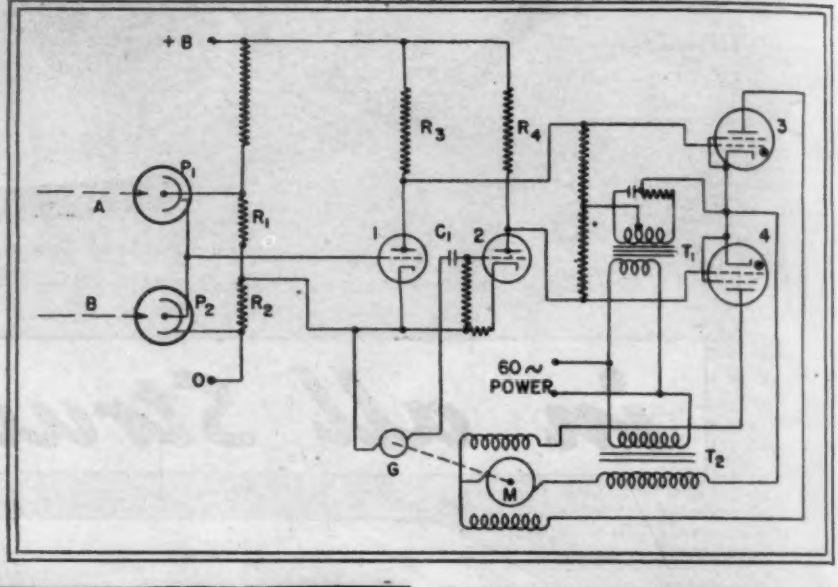
AN ELECTRONIC MACHINE that contains a polarized light servo-system has been successfully applied to the accurate solution of problems involving integration. One of these applications is that of testing samples of turbine nozzles through which steam is normally supplied at a rate of 1200 miles per hour.

In the test, compressed air is substituted for steam and is passed through the nozzle at various pressures while the instrument measures, records and adds up energies at various points on the nozzle. The integrated values of the flow phenomena check each other within 0.01 percent on repeated integration of the same function. The small error appears to be due to mechanical tolerances.

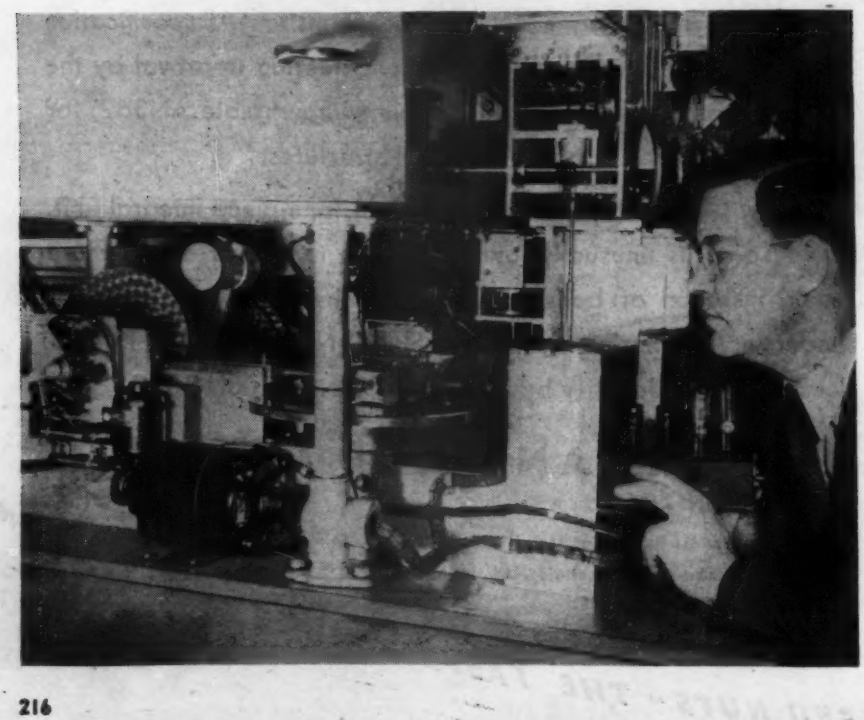
The photograph shows the polarized light servo-system as used in the General Electric integrating pressure traverse recorder, which employs two follow-up systems as integrators. This is used by the Research Section of the G-E Electric Turbine Engineering Division in its air test laboratory for studying flow phenomena through turbine passages.

Fourteen of the integrating units, each with its own polarized light servo-system, are contained in the G-E differential analyzer which is used in solving problems involving the use of differential equations. The principles of operation of the polarized light servo-system were described by T. M. Berry of the G-E General Engineering Laboratory in a paper delivered at the AIEE winter technical meeting in January.

The mechanical arrangement of the units of the system is shown in the drawing. A small integrating wheel rolls on the surface of a turntable at an adjustable radius r. On the shaft attached to the wheel is mounted a light-polarizing disc or



Simplified circuit of the electronic control unit used in the polarized light servo-system



T. M. Berry of G-E installs the phototube unit in the calculating machine used for integration and differentiation. Fourteen of these machines are contained in the G-E differential analyzer

primary polarizer. Two beams of light, A and B, passing through the primary polarizer are polarized similarly and the plane of polarization rotates as the primary shaft rotates.

A secondary shaft is, in effect, coupled to the primary shaft by means of these two rotating beams of polarized light in the following manner. The two beams of light fall on two phototubes after each has passed through a separate sec-

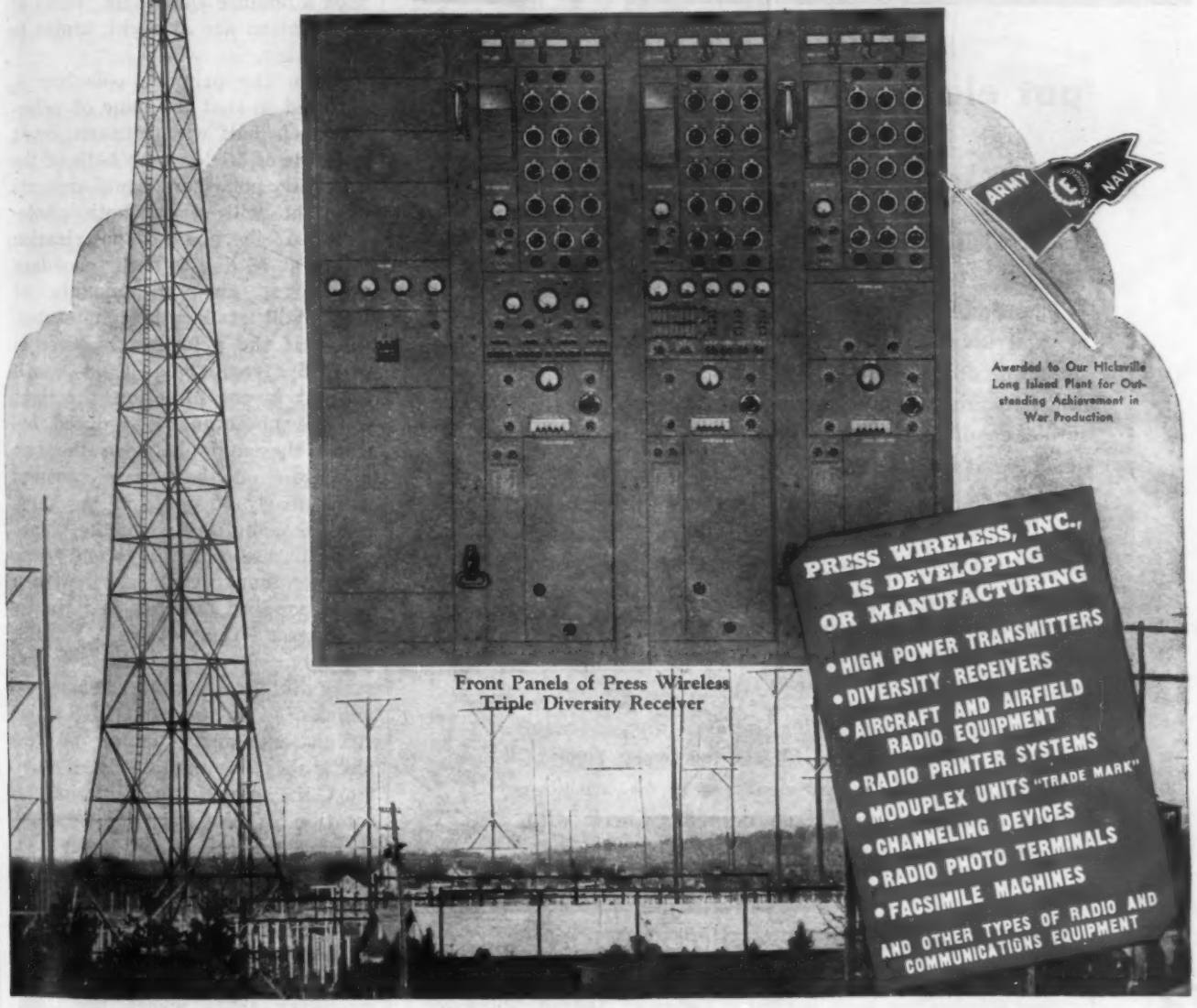
NEW YORK • CHICAGO • LOS ANGELES • LONDON • HAVANA

PRESS WIRELESS PROVIDES RADIO CENTRALS FOR THE WORLD...

Triple diversity receivers made by Press Wireless Inc. for our allied governments will soon be in service as radio centrals for national and international communication networks of increasing strategic importance.

The facilities of Press Wireless are peculiarly adapted to the manufacture of these and other highly specialized units so urgently needed for the winning of the war.

This is one reason why Press Wireless was selected as a principal supplier of various type of radio equipment now in use on home and battle fronts throughout the world.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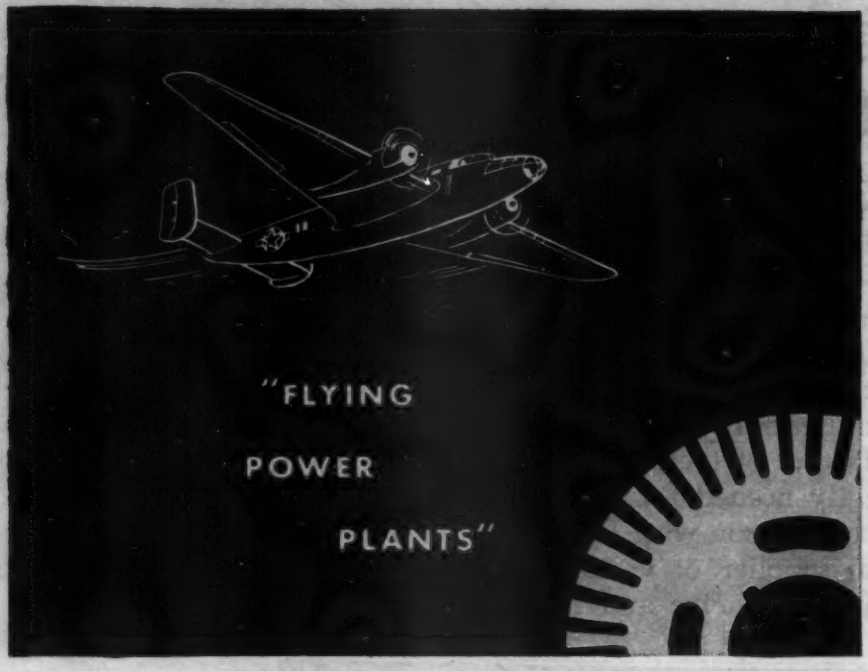

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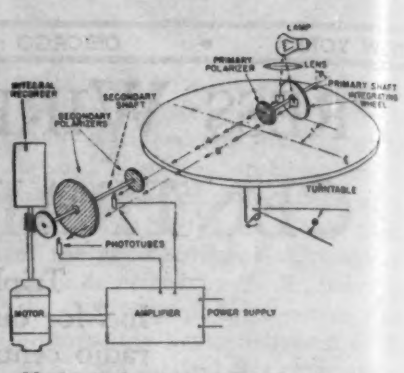

Mechanical arrangement of units forming the polarized light servo-system as contained in an automatic integrating pressure traverse recorder used for studying flow phenomena through turbine passages

ondary or control polarizer. These two secondary polarizers are attached to the secondary shaft in such a manner that their planes of polarization are at right angles to each other.

When the primary polarizer is oriented so that its plane of polarization is half way between, or at an angle of 45 deg with both of the secondary polarizers, equal amounts of light will strike both phototubes. If the plane of polarization is not at 45 deg to both secondary polarizers, unequal amounts of light will strike the phototubes. Thus, if the primary polarizer is rotated from balance a small amount in one direction, the light on one phototube is reduced because the angle between the two polarizers in that beam becomes more nearly 90 deg.; at the same time, the angle between the planes of polarization in the second beam becomes more nearly zero, with a corresponding increase in light on the second phototube. If the primary polarizer is rotated in the other direction the light beams are unbalanced in the other direction.

The unbalanced ouput of the phototubes is amplified and controls the speed and direction of rotation of the servo-motor, and thereby the secondary shaft and polarizers, to keep the light on the phototubes always at or near balance.

There are four positions of the primary shaft with respect to the secondary shaft where the light beams may be balanced. Only two of these positions, however, will give a condition of stable balance. Once the condition of stable bal-

ance has been established it is maintained and the secondary shaft will rotate with the primary shaft in either direction within the allowable limits of speed, acceleration, and load as determined by the motor and amplifier characteristics.

The axis of the primary shaft is held by bearings parallel to the plane of the turntable surface. For changes in radius of contact of the integrating wheel, the primary shaft and polarizer can be moved axially along the two light beams without materially affecting their balance.

Electronic Circuit

A simplified schematic diagram of the control circuit is shown. The two light beams fall on phototubes P_1 and P_2 which form two legs of a bridge circuit comprised of R_1, R_2, and the resistances of the two phototubes. The voltage unbalance of this bridge is applied between grid and cathode of VT_1. This tube together with VT_2 and resistances R_3 and R_4 form a second bridge circuit whose output is applied to the grids of two thyratron tubes, VT_3 and VT_4.

The anode currents of the thyratrons, supplied from the 60-cycle power source through transformer T_2, flow through a split field series motor to control its speed and direction in response to unbalance of the light beams A and B.

A small d-c generator is attached to the shaft of the motor and its output voltage is applied through a capacitor (C_1) between the grid and cathode of tube VT_5. The voltage (e) generated by this generator is proportion to the speed ω of the secondary shaft. For the frequencies encountered the current through C_1, and therefore the voltage across the grid resistor of tube VT_5, is proportional to de/dt, and is therefore proportional to $d\omega/dt$, the acceleration of the output shaft. Thus, the condition of balance of the two light beams is anticipated, and the system is stabilized and remarkably free from the hunting or oscillation commonly experienced in servo-systems.

A single lamp is used as a light source for both beams of light so that any changes in the light output due to aging, darkening of the

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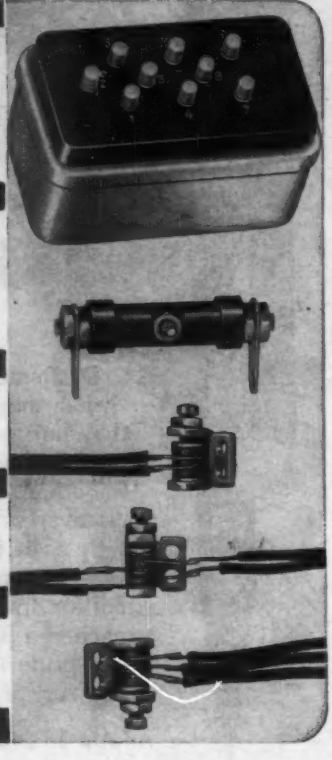

BX-22.3 Double bridge rectifier with current and temperature-current characteristics balanced to better than 1% over a range of −40°C to +70°C. Rated up to 4.5 volts A.C., 3 volts D.C., 5 milliamperes D.C.

BX-100 Center tap, full wave rectifier. Completely enclosed in Bakelite. Low capacitance. Rectifies high frequency current. Rated up to 4.5 volts A.C., 3.0 volts D.C., 500 microamperes D.C.

BX-22.5 Single half-wave rectifier rated up to 4.5 volts A.C., 3.0 volts D.C., 2.5 milliamperes D.C.

BX-22.2 Full wave rectifier rated up to 4.5 volts A.C., 3.0 volts D.C., 5 milliamperes D.C.

BX-22.4 Double half-wave rectifier rated up to 4.5 volts A.C., 3.0 volts D.C., 2.5 milliamperes D.C.

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bulb, and input voltage affect equally the light falling on both phototubes, causing no unbalance of the system. The bridge circuits employed also make the electronic circuits relatively free of unbalance due to supply voltage fluctuations.

The torque, angle characteristics of the polarized light servo-system are dependent on the characteristics of the amplifier and motor. Within operating limits the torque is approximately proportional to the relative angular displacement of the light polarizers at any given speed. Series motor characteristics make possible very high torques for rapid acceleration and deceleration. It is estimated that the primary shaft can accelerate or decelerate at 2,000 rpm per second or more before the secondary shaft will drop out of synchronism. Speeds as high as 1,500 rpm have been used but this is not necessarily the upper speed limit.

The secondary shaft will follow the primary shaft in angular position with an accuracy of plus or minus one or two degrees. This accuracy will be affected by non-uniformity of polarization in the polarizers and non-uniformity of light transmission through them. Since the primary and secondary polarizers normally operate at 45 deg to each other, the rate of change of light transmission with respect to angular displacement is a maximum. Therefore, the angular errors due to variations in the polarizers are at a minimum.

Integration

For accurately solving problems involving integration, the radius r at which the integrating wheel rolls on the turntable is variable by means of a cam or screw and represents the integrand.

If θ is the angular displacement of the turntable, the angular displacement of the integrating wheel and primary shaft ρ is proportional to $r\,d\theta$, or $\rho = k.\int r\,d\theta$.

The angular displacement of the secondary shaft is the same as that of the primary shaft and integrating wheel, and, since considerable power is available to drive this shaft, it can be loaded to drive other calculating and recording mechanisms. The primary shaft is

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held in alignment by jewel bearings and is balanced so that radial and thrust loads are substantially zero. Since there can be no restraining torque on the primary shaft due to loading of the secondary shaft, the integrating wheel rolls on the turntable with negligible slippage and correspondingly high accuracy.

The secondary shaft is at right angles to the primary shaft and the light beams are changed in direction by means of mirrors.

The photograph of the machine shows the cams for moving the integrating wheels on the turntables. The driving motors and thyratron controls are on the shelf above the turntables and cams.

Speed Measurement

In another application a variation of this servo-system has been used to accurately measure over a wide range the speed of a large rotating machine. The turntable is driven at a constant and accurately-known speed by a synchronous motor from a regulated frequency source. The secondary polarizers are driven by the machinery whose speed is to be measured and the wheel is positioned on the turntable so that it follows the secondary polarizers, thus the radius of the wheel on the turntable is an accurate measure of the unknown speed. Speed measurements have been made to 0.025 percent accuracy for primary shaft speeds up to 1300 rpm.

Differentiation

In the measurement of speed as described above, the servo-system is actually used as a differentiator in which the angular displacement of the secondary polarizers ρ' may be expressed by the equation: $\rho' = \int \omega_1 dt$ where ω_1 is the angular velocity of the control polarizers.

The angular displacement of the primary polarizer ρ is expressed by $\rho = k \int r \, d\theta$, $\theta = \omega_2 t$, *where* ω_2 is the angular velocity of the turntable, $d\theta = \omega_2 dt$.

If $\rho = \rho'$, then $d\rho = d\rho' = \omega_1 dt = k\omega_2 r dt$ and $\omega_1 = d\rho'/dt = d\rho/dt = k\omega_2 r$. Since ω_2 is constant, $d\rho'/dt = Kr$.

When used as a differentiator, the servo-system is inherently oscillatory, but by taking the proper

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steps the oscillations can be highly damped.

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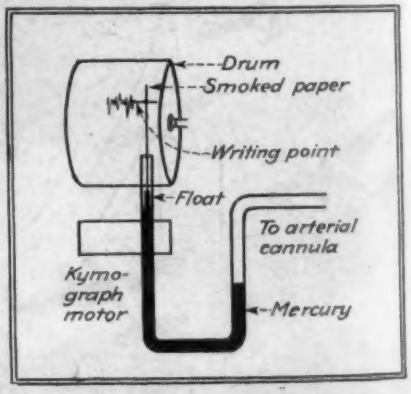
• • •

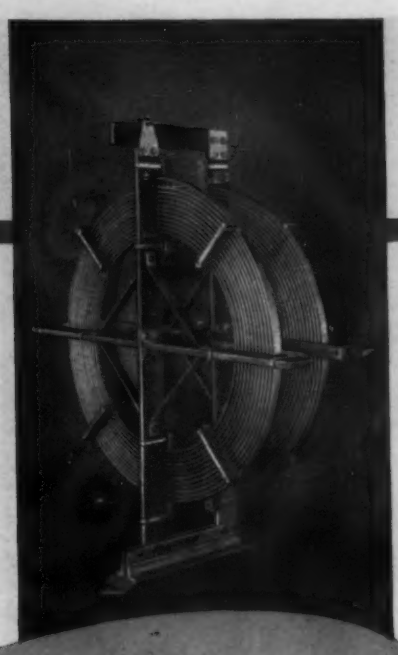
Photo Tube for Biological Recording

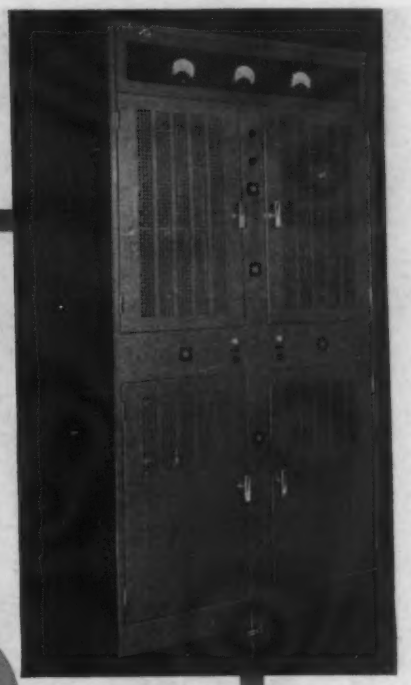
A DEVICE FOR transforming motion of a column of mercury or other opaque fluid into a corresponding motion of a power-driven pen is described by Sergei Feitelberg, of Mount Sinai Hospital in New York, in the *Proceedings of the Society for Experimental Biology and Medicine* for February, 1942. This is an application to a physiological problem of a method used in several recording meters for controlling a pen.

The method ordinarily used in physiological recording of pressures requires a vertical kymograph with smoked paper. A wide manometer tube with a light float connected to a writing point lightly touching the paper produces the record. Very little pressure on the writing point can be used, as the float is easily submerged. A wide manometer tube is necessary in order to provide better support for the float, but has the disadvantage of drawing several cc of blood from



The conventional method used in recording blood pressure consists of transmitting the pressure variations to the writing point on the smoked paper by means of a float in a manometer tube





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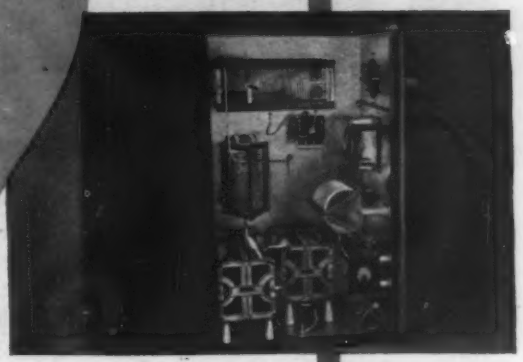

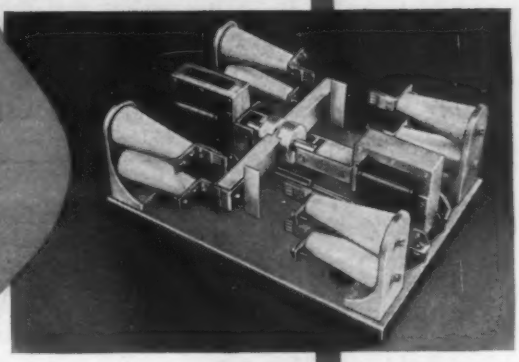

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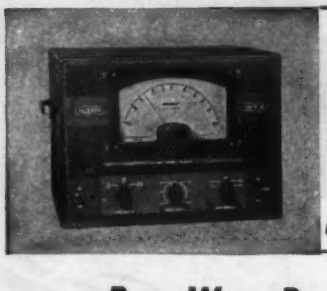

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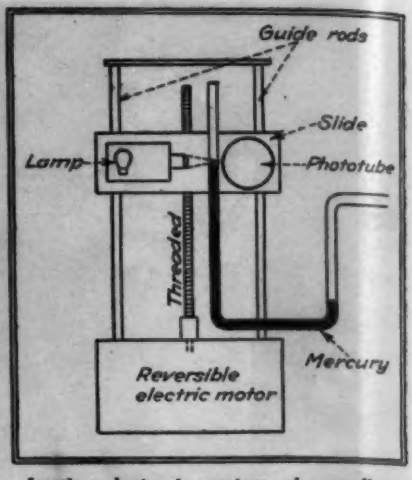


In the electronic system of recording blood pressure, the light beam and phototube cause the motor to correct the position of the slide constantly at a rate of two oscillations per second over a distance of 1 to 2 mm. When the mercury column moves due to variation of pressure, the motor moves the slide at a rate of 20 mm per second

the vessels of an animal when a rise in blood pressure occurs.

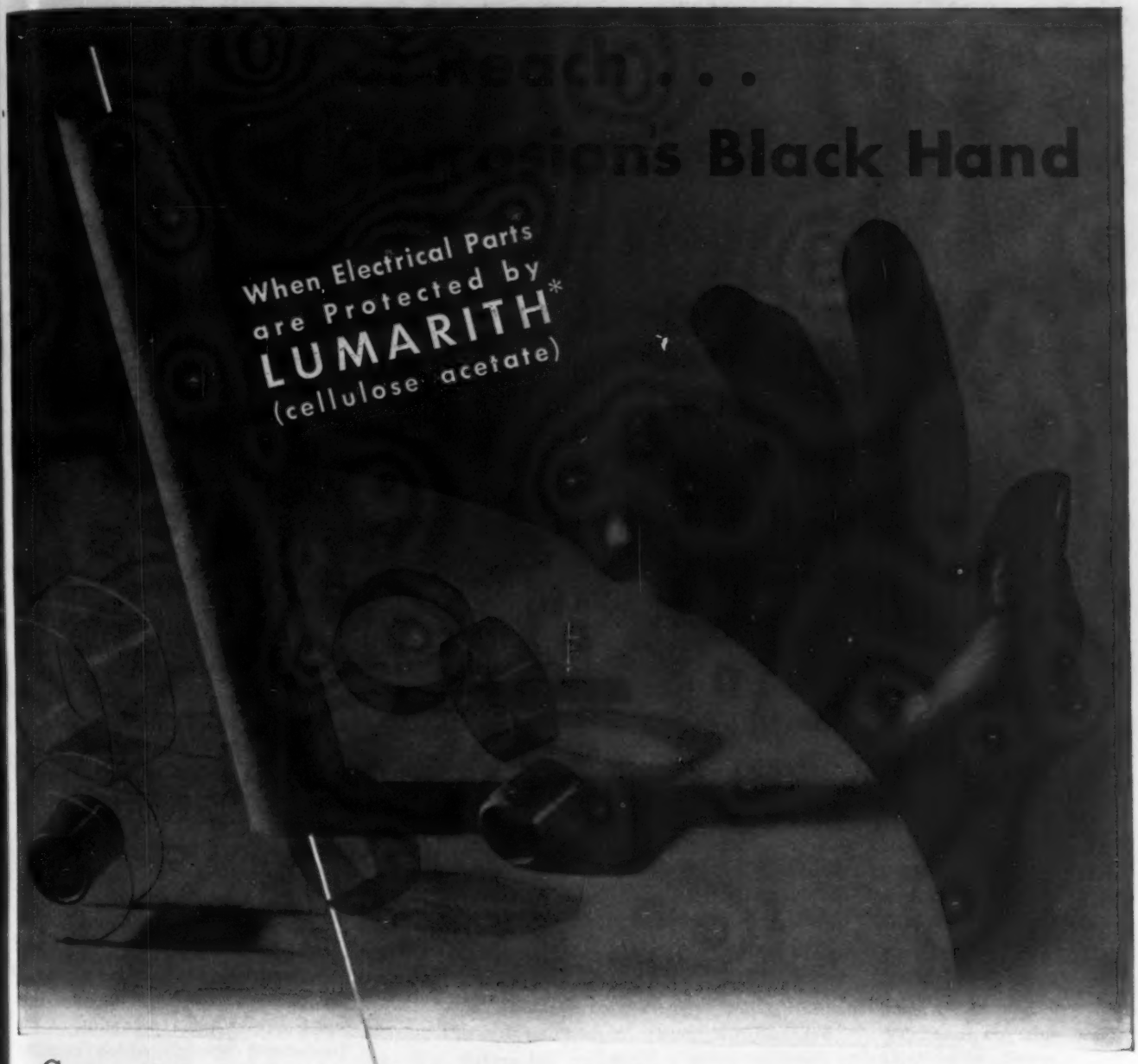
In the apparatus described, a light beam is used instead of the float. A slide carries a lamp and phototube. It has a female thread, engaging a threaded brass rod, which controls the position of the slide with respect to the mercury column. The rod is rotated by a reversible electric motor, and the slide raised and lowered, depending on the direction of rotation of the motor. This factor is controlled by a phototube-amplifier-relay combination.

The light from the lamp is directed to the manometer tube. If it is prevented from striking the phototube by the mercury column, the motor rapidly raises the slide until the light beam is above the mercury. The light hitting the phototube causes the relay to reverse the motor, and the slide is lowered until the light beam is again interrupted. This oscillation continues over a distance of 1 to 2 mm, at a rate of 2 per second. If the mercury column is moving, the slide follows at a rate of 20 mm per second.

The advantages of this method over an ordinary float with a pen recording on a smoked drum are given as follows:

1. Any system of recording can be used, as the power is supplied by the motor.

2. A very thin mercury column



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can be used, reducing the change in volume in the system in which the pressure is being measured. This is rather important for recording arterial pressures in small animals.

3. The deflection of the manometer can be amplified by mechanical means, by connections between the moving photocell assembly and the pen. Amplification can also be obtained by inclining the manometer tube; the amplificaton factor is $1/\cos a$, where a is the angle between the tube and the vertical. —W.E.G.

• • •

Simple C-R Tube Voltmeter

A NEW TYPE of cathode-ray tube that uses the shadow of an obstacle placed in the path of the electron beam as an indicating pointer for the measurement of high voltages is described in by W. Ehrenberg and H. Hirsch in the October, 1943 issue of *Journal of Scientific Instruments* (The University, Reading, Berkshire, England). Voltages up to 50,000 are measured directly by the tube without deflecting plates or special focusing.

In the tube, a fine crossover is formed a little in front of a circular aperture placed in front of an emitting cathode, so that the electrons that emerge from the aperture may be considered to originate from this crossover point as from a point source. An obstacle placed in the path of the beam beyond this point throws a sharp shadow on the fluorescent screen, which remains sharp for all values of the anode voltage. A suitable obstacle consists, for example, of an oblong aperture along which is stretched a fine wire. The beam then passes through the field of a small permanent magnet by which it is deflected as a whole. Some distortion due to the non-homogeneity of the field and to the variation of the angle at which the beam hits the screen results but there is no loss of definition.

A good idea of the scale can be obtained by assuming the field to be short and uniform. Then for a screen normal to the undeflected beam (as in the ordinary cathode-ray tube) situated at a distance L beyond the end of the field the position of the shadow is given by $x = ML/\sqrt{V} - a$ where M is a con-

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In many ways General Electronics Industries has been helping to establish the great war record of electronics, through cooperative research with industrial organizations and Army and Navy research agencies. Present conditions do not permit a full recounting of these achievements.

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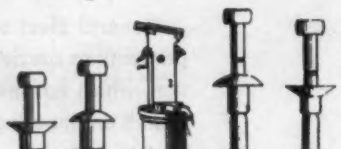

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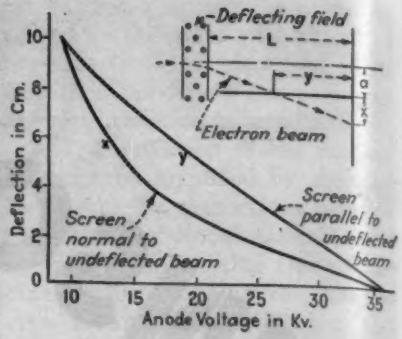

Fig. 1—Placing the screen parallel to the axis of the undeflected beam provides the nearly linear calibration curve shown above

stant depending on the field and $(x + a)$ is the distance of the pointer from the axis; $x = 0$ for $V = V_{max}$. If, however, as in the new tube, the screen is placed parallel to the axis of the undeflected beam, the position of the pointer is given by $y = L - \sqrt{V}.\ a/M$. Here again $y = 0$ for $V = V_{max}$.

The variations of x and y with voltage are shown in the two curves of Fig. 1; the constants are different for the two curves, being so chosen that the range from 9 kv to 36 kv shall extend over 10 cm of the scale in each case. It will be seen that the new scale is nearly linear.

Tube Assembly

The construction of the new tube is shown in Fig. 2. The cathode consists of a fine tungsten wire in the form of a hairpin, supported on a ceramic base. In front of the bend of the hairpin is a cathode screen with a 0.03 in. circular aperture. This is electrically connected with the negative high voltage, and also, through a half-megohm resistor, to the filament, so that the cathode is maintained with a positive bias to the cathode screen. The total current passing through the tube amounts to about 10 μa, and is almost independent of the voltage. The drain imposed on the source is therefore very small and the heat produced by the electron beam at any part of the tube is negligible.

The whole upper part of the tube forms the anode; it is metallized on the inside except for a strip down the side covered by the fluorescent screen. A nozzle extends downwards from the upper portion to

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within about 1 cm of the aperture. This part of the construction follows closely that given by Pearce.[7] The obstacle consists of a straight wire 0.004-in. diameter stretched over an oblong aperture. This is placed about 1.5 in. up the nozzle. At a farther distance of about 2 in. is the small magnet giving the deflecting field, which is clamped on the outside of the tube.

For a steady response the inside of the tube must be free from stray electric fields such as would be produced by any areas not in electric contact with the metallized surface. For this reason the fluorescent screen is deposited on a thin undercoating of zinc oxide.[8] The zinc oxide is remarkably photo-conductive, and, so formed, the whole screen becomes conducting, and will therefore be at the same potential

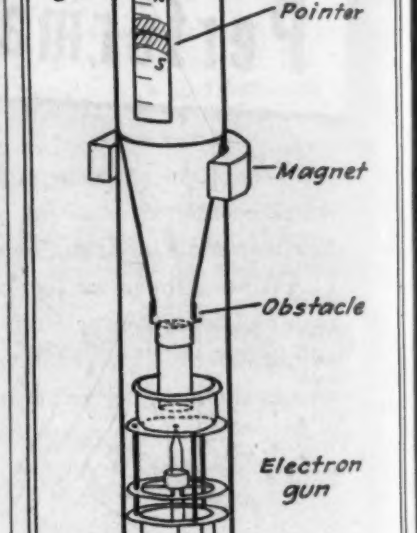

Fig. 2—Mechanical arrangement of the elements forming the electronic voltmeter for measuring high voltages

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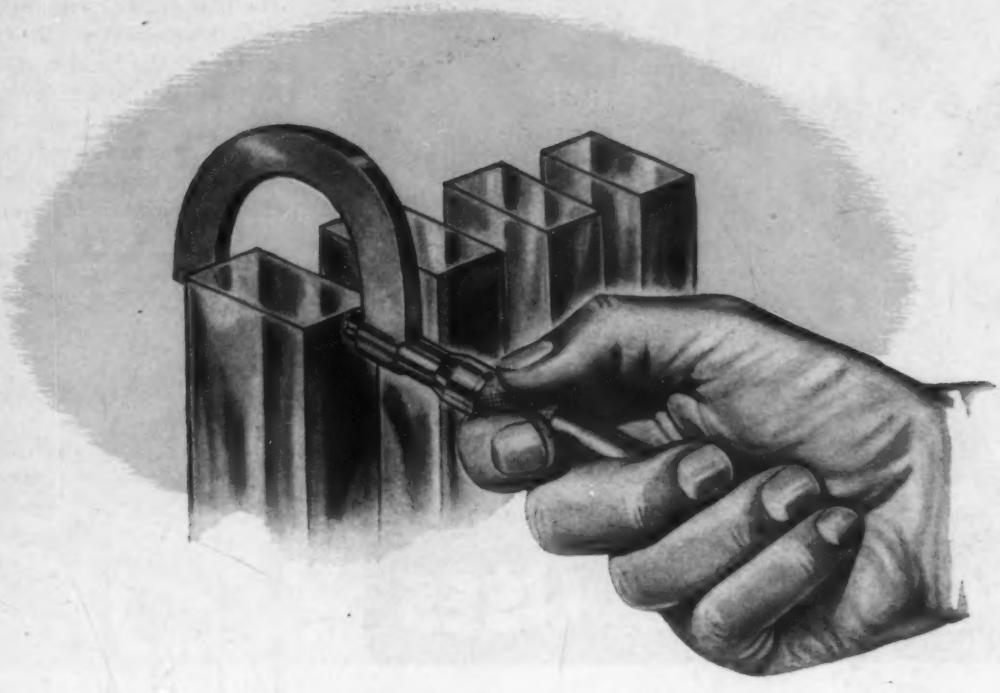

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as the rest of the inner surface. All metal parts are well degassed before they are inserted in the tube and the tube is highly evacuated with the usual precautions and sealed off.

The only accessory required is a filament transformer, of small dimensions if the negative high voltage is grounded. A circuit diagram is given in Fig. 3. The luminous pointer appears on the scale when the filament is heated and the high voltage connected. The inhomogeneity of the field and the curvature of the screen cause a slight curving of the pointer which increases towards the high-voltage end of the scale. A sufficient definition is maintained over a 10 cm scale, so that the voltage can be read to within 3 percent over the whole scale. It would seem possible to eliminate the pointer curvature though the effect was not found disturbing enough to warrant a sacrifice of simplicity.

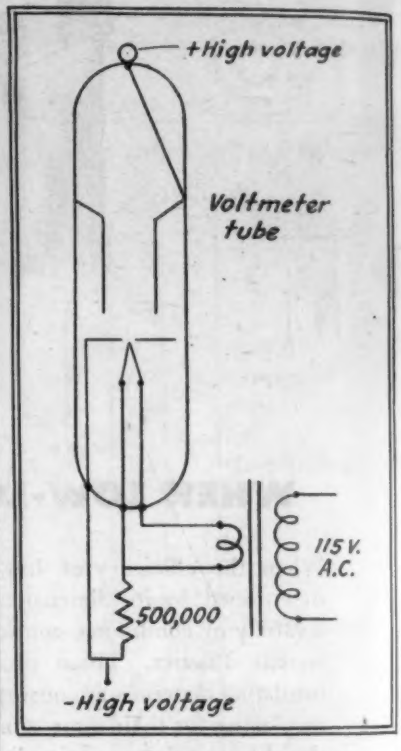
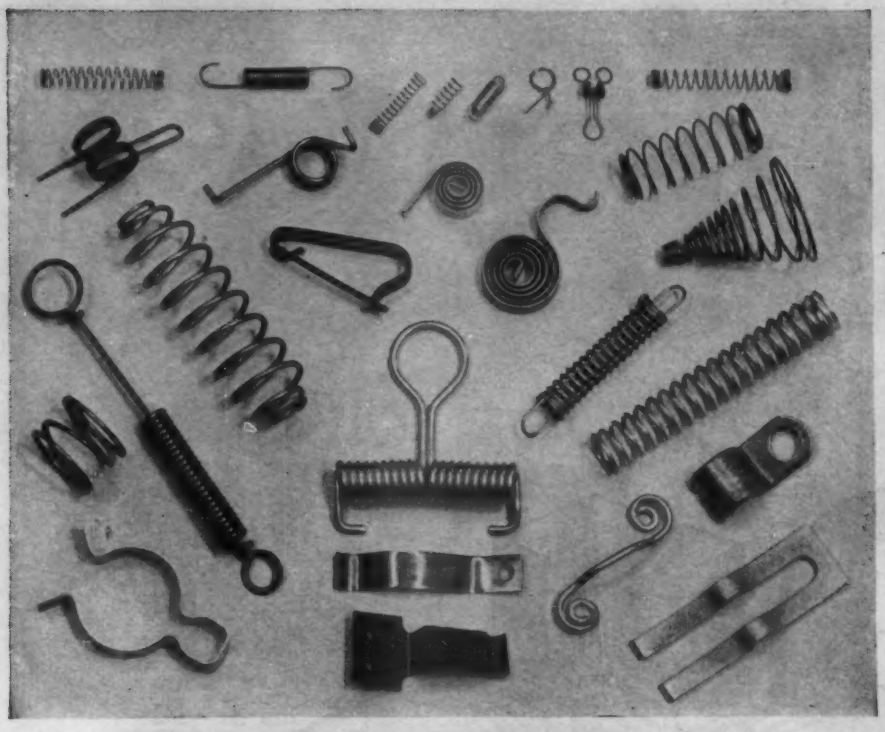


Fig. 3—The high voltage to be measured connects between the cathode screen and the anode formed by the upper part of the tube

The range of the meter depends on the strength of the magnet; a magnet giving the instrument any voltage range desired is easily obtained. A number of different magnets were tried, but no very



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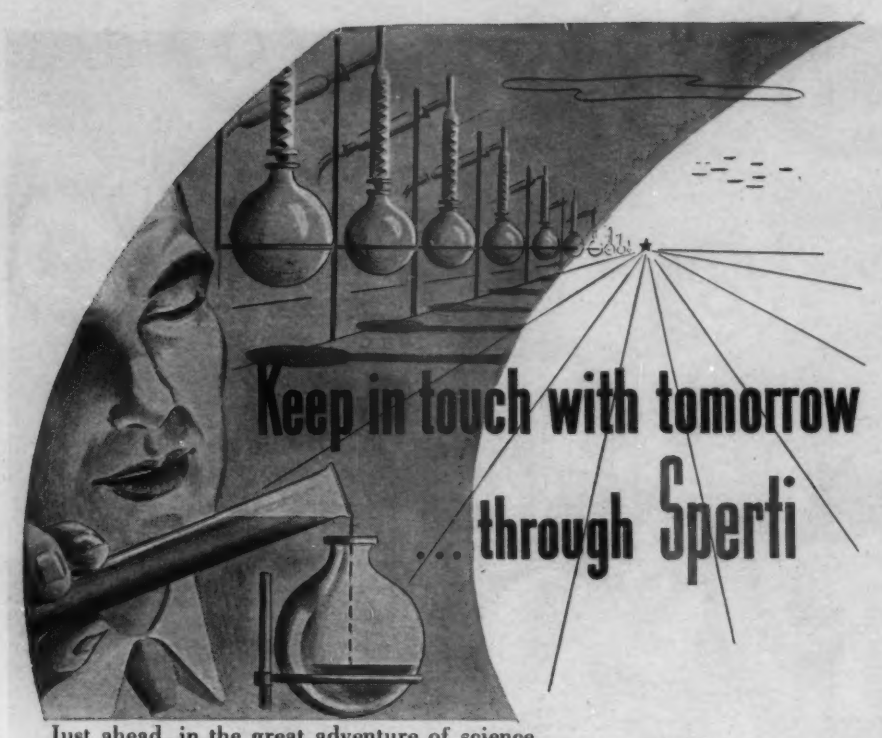

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great superiority was found for any particular shape. A steel ring magnetized across a diameter appeared to give a slightly more homogeneous field than the U-shaped magnet shown. The magnet is clamped in position by a simple non-magnetic clip (not shown) that may be sealed in position with some sealing wax. The constancy of the scale depends critically on that of the magnet. A limit is set to the voltage applicable by the electric strength of the tube; the particular tube described was tried up to 40 kv.

Calibration

As the diameter of the tube is only about 4 cm, the glass may be quite thin and no grave parallactic error is incurred by having the scale on the outside. The earth's magnetic field causes an additional deflection of the pointer of a few millimeters that is noticed if the tube is turned. The earth's field can be allowed for either by keeping the tube always vertical and facing the same direction or, approximately, by setting the magnet according to the direction of the tube. With these precautions no magnetic shielding was found necessary.

For poorly smoothed d.c. a narrow slit is preferable to the obstacle described as the shadow of the thin wire becomes obliterated when the pointer moves rapidly. The tube can then be calibrated to read peak voltage on the upper edge of the patch. The same applies

• • •

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Some of the indicating instruments and operating controls of the flight engineer's panel aboard the mammoth Navy flying boat MARS

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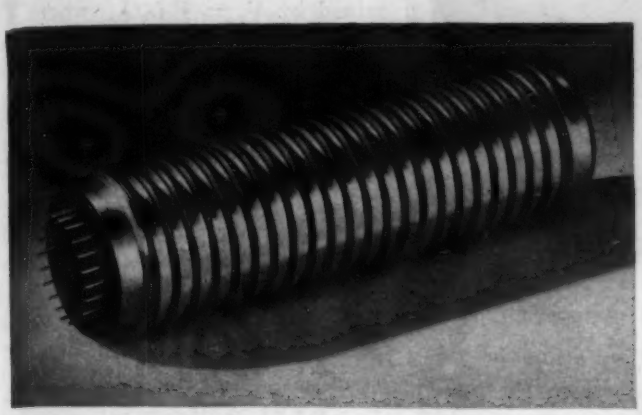

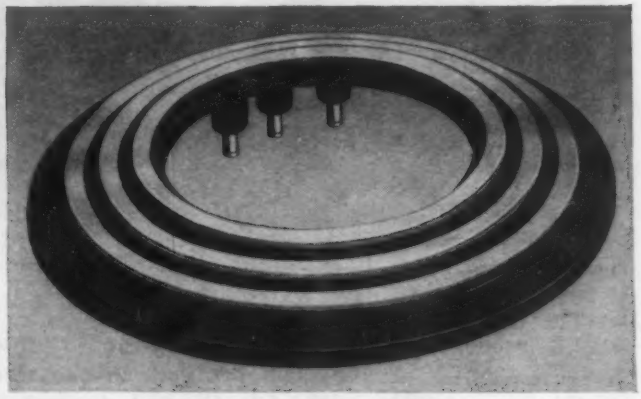

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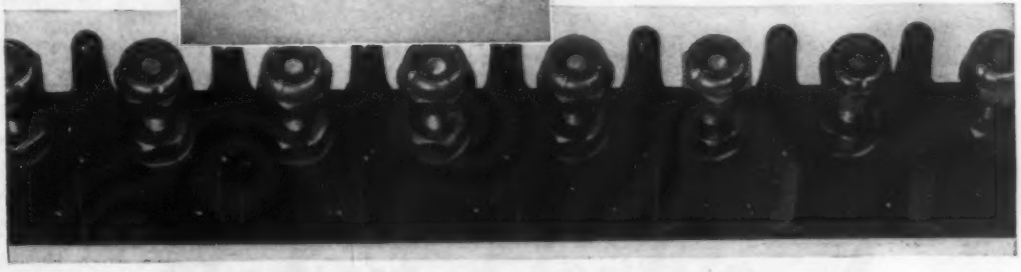

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to pure a.c. though the breakdown voltage of the tube might be lower for the inverse phase.

Although it is not possible to calibrate a tube with a permanent magnet without reference to an independent meter, a tube as described may also be used for establishing a voltage scale with reference to a known voltage of a few kilovolts, if the steel magnet is replaced by a coil without an iron core. An unknown voltage V_2 is determined by $V_2 = V_1 L_2 / I_1$, where V is a known voltage and I_1 and I_2 are the currents passing through the coil for the same position of the pointer. Here again the earth's field must be taken into account and compensated.

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(7) Pearce, A. F., British Patent 527,980 (1940).
(8) British Patent 479,306.

• • •

Converting Coordinates With A Mannheim Rule

By Richard W. Crane

The conversion of rectangular to polar coordinates, and from polar back to rectangular a number of times, is often a tedious process. The use of a loglog vector slide rule greatly eases this task. However, it is not generally known that these conversions can also be rapidly and fairly accurately accomplished with the use of a few short cuts and a maximum of two settings on a Mannheim slide rule.

The methods for converting $R - jX$ to $Z\angle\theta$ are as follows:

Procedure 1. Where one component is 10 or more times the other: assume Z = larger component (maximum error 5 parts per 1,000).

To find the phase angle, place the right-hand index of the "S" scale under the value of the larger component on the right side of the "A" scale and place the glass indicator over the value of the smaller component on the left side of "A" scale. Read the phase angle on the "S" scale. If the reactance value is greater than that of the resistance,

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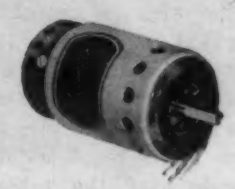

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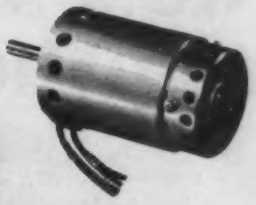

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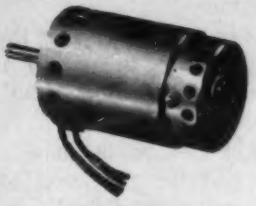

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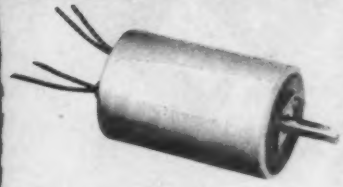

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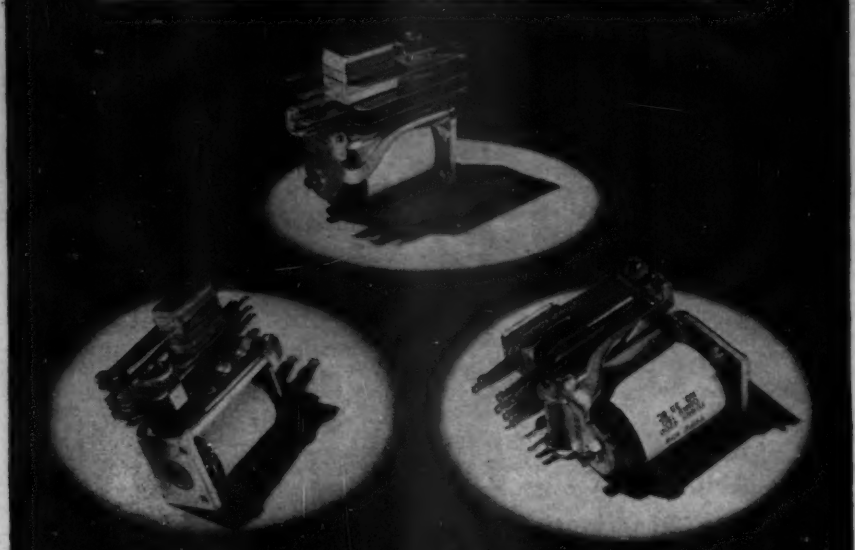

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the phase angle will be $\pm(90° -$ reading). This operation is based on the fact that, for very small angles, the sine is almost equal to the tangent, approaching it in value as the angle approaches zero.

Procedure 2. Where one component is less than 10 times the other.

Place right hand index of the "T" scale over the value of the larger component on the "D" scale. Place the glass indicator over the value of the smaller component on the "D" scale and read the phase angle on the "T" scale.

Set this angle on the "S" scale under the value of the smaller component on either end of the "A" scale. The right hand index of the "S" scale will give the value of the impedance.

As in Procedure 1, if the reactive component is the larger the actual phase angle will be $\pm(90° -$ reading).

This method is an exact operation and the precision of the results will depend solely on the slide rule used.

Example—Convert $130 + j2500$ to polar coordinates.

Solution. Procedure 1 applies here, therefore $Z = 2500$ ohms. By placing the right hand index of the "S" scale under 2500 on the right end of the "A" scale and the glass indicator over 130 on the left side of the "A" scale, we read 2° 59′. By inspection it is seen that the impedance is predominantly inductive, therefore the phase angle equals 90° − 2° 59′ or 87° 1′.

Answer. $2500 \angle 87° 1'$. (Actual value $2503.8 \angle 87° 2'$).

Example—Convert $400 - j300$ to polar coordinates.

Solution. Using Procedure 2, place the right hand index of the "T" scale over 400 on the "D" scale, put glass plate over 300 on the "D" scale and the angle is seen to be 36° 50′. Set 36° 50′ on "S" scale under 300 on "A" scale, read 500 above the right hand "S" index. The resistive component is larger than the capacitive, therefore the above angle is correct, except for sign.

Answer. $500 \angle -36° 50'$.

To change from polar coordinates to rectangular, the operations are simply reversed, unless the problem comes under procedure 1, in which case we assume only one component is present.

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NO! IT'S NOT NEW TO US! FOR OVER 23 YEARS OUR HIGH FREQUENCY HEATERS HAVE BEEN FAMILIAR TO LEADING VACUUM TUBE MANUFACTURERS AS "BOMBARDERS"

High frequency heating may be "something new" to manufacturers who have *recently* entered this field. But we have been pioneering in design and manufacture of high frequency heaters for *23 years.*

However, because so many users are *new* users, unfortunate ERRORS are being made, both in choice of equipment and in application. Too many users are operating costly, power-wasting "misfit" units . . . machines NOT designed for their particular needs.

Our equipment is the result of 23 years of specialized knowledge and pioneering. Our machines afford advancements which overcome widely prevalent errors in design and construction. Compare our experience with that of others. You can benefit by what it has taken us almost a quarter of a century to learn.

Don't buy high frequency (induction or dielectric) heating equipment until you have investigated the production economies and other advantages offered by our wider range of units — designed for YOUR specific applications.

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Our equipment offers you a selection of frequencies up to 300 megacycles — and the following power range, with stepless control from zero to full load:

5 Kw
7½ Kw
10 Kw
12½ Kw
15 Kw
18 Kw
25 Kw
40 Kw
100 Kw

Scientific Electric

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divided the land...united the world

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Long before the Canal was completed, Foote, Pierson telegraph and signaling apparatus was in use by the Panama Railroad—the railway which had a vital role in the construction of the Canal.

For nearly a half century, Foote, Pierson & Co., have specialized in the manufacture of communications equipment and precision instruments. To this may be attributed the careful craftsmanship and attention to minute detail which has distinguished our mass production during the present period.

This background of knowledge and experience can be applied, in cooperation with your Product Engineers, to the design and manufacture of your post-war products.

Don't wait for V-day, write to us now!

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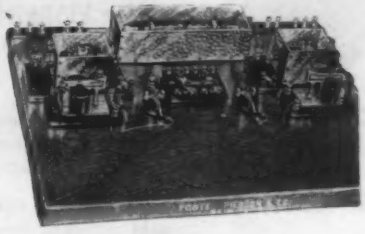

Foote, Pierson repeater telegraph set as supplied to the Panama Railroad

ARMY (E) NAVY

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Harnesses — made to your toughest "specs" — that's one of our big dishes. Several internationally known radio manufacturers can tell you that Wallace methods help them get the production they want. Of course, it's all in winning the war but it's fine training for competitive peacetime operation, too. Perhaps we can use this experience to help you get the jump on competition once peace is declared.

Wm. T. Wallace Mfg. Co.
General Offices: PERU, INDIANA
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Electron Gun for X-Ray Tube

THE USE OF an electron gun as a source of cathode-rays to minimize contamination of the target by material evaporated from the filament, along with the effect of the space charge in limiting the target current at low voltages, are described by J. J. G. McCue in the Nov. 1943 issue of *Review of Scientific Instruments*. The arrangement also offers the additional advantage of adjustable focal-spot size.

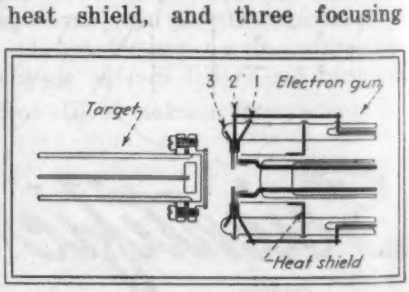
A successful tube has been constructed, using a cylindrical stainless steel shell 5 in. long, 4 in. in outside diameter, and ¼ in. thick. The target insulator is an 8-inch length of standard Pyrex flanged pipe, 1½ in. inside diameter, mounted on one end of, and coaxial with the stainless steel body. The other end of the tube bears a sylphon bellows with a flange soldered on each end. One flange serves to connect the bellows to the tube body, through a fuse wire gasket. The electron gun is mounted on a stainless steel plate screwed to the other flange, the seal being made with a rubber gasket.

Three threaded rods, parallel to the axis of the bellows and 120 deg apart around the circle, carry knurled nuts which bear on either side of the flange holding the gun. By adjusting the nuts, the bellows moves the electron gun toward or away from the target, or moves the focal spot about on the target.

A brass water-jacket is shrunk onto the tube body to cool it. A port on top of the tube permits visual observation of its interior.

Construction of Gun

The electron gun assembly is shown in the illustration and consists of a filament, a cylindrical heat shield, and three focusing



Arrangement of the electrodes forming the electron gun. The filament, not completed for clarity in the illustration, consists of a single circular loop of oxide-coated nickel strip

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Optimum in Superiority — Flexible — Resists High Temperatures, Oils, Acids, Dielectric to 8,000 Volts — Unequalled for Long Life under Most Severe Conditions.

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Long Staple Fibre Yarn Varnished Tubings are comparable in many ways to Fiberglas . . . Dielectric — Tensile Strength — Flexibility and Long Life.

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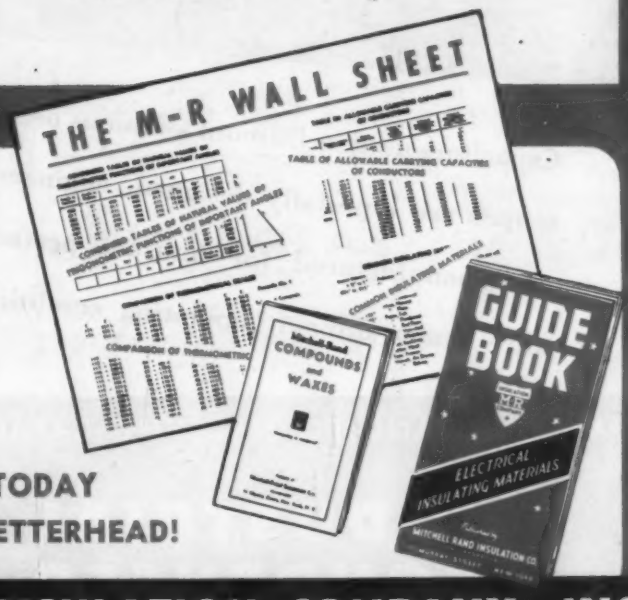
Write today for your Free Card of Varnished Tubing with samples ranging from size 0 to 20 to fit wires from .032 to .325 inches . . . other valuable aids, are the M-R Guide Book of Electrical Insulation . . . the Wall Chart with reference tables, electrical symbols, allowable capacities of conductors, dielectric averages, thicknesses of insulating materials and tap drill sizes . . . and the M-R Wax and Compound Guide Book . . . they are full of valuable information . . . write for them on your letterhead.



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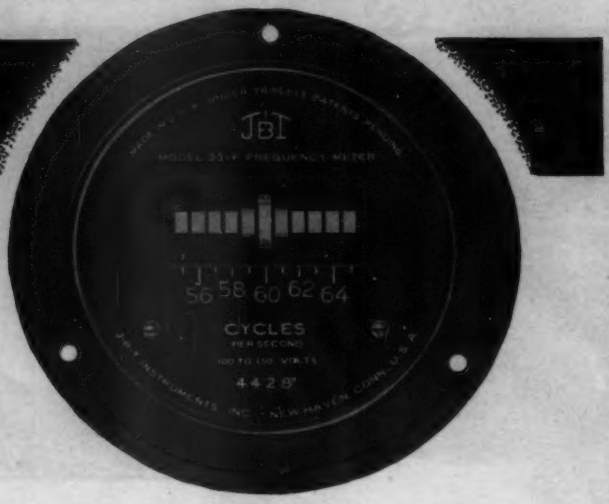
Fiberglas Saturated Sleeving and Varnished Tubing
Asbestos Sleeving and Tape
Extruded Plastic Tubing
Varnished Cambric Cloth and Tape
Mica Plate, Tape, Paper, Cloth and Tubing

How to Get Your Money's Worth in **FREQUENCY METERS**



Check These Points

Model 33-F, Full-cycle increment, shown indicating frequency of 60 cycles. Black dial for special war application.

Here are the facts on

J-B-T VIBRATING REED FREQUENCY METERS

ACCURACY — Half-cycle increment, ±0.2%; full-cycle increment ±0.3%. This accuracy is not affected by normal *temperature* change, *wave form* or *external magnetic* fields.

COMPACTNESS — Made in several sizes, most popular of which is the standard 3¼" panel mounting model. Also made to meet C39.2-1943 ASA specifications for mounting and stud size of Electrical Indicating Instruments. No external reactor.

WEIGHT — Model 31-F, 3½ inch, 5 reeds, weighs only 0.54 lb; Model 33-F, 3½ inch, 11 reeds, 0.59 lb. Other models are correspondingly *light*.

VOLTAGE VARIATION — Will operate on voltages as low as 8 volts. Standard 110-115 volt models will operate satisfactorily over range of 100 to 150 volts. Also made for narrower voltage variation if desired. (Incidentally, current consumption is low. For Model 33-F, for example, ½ watt at 115V.)

RUGGEDNESS — No parts to wear out or get out of calibration. All are securely anchored to the base with lock washers at every critical point. The only movement is at the free end of the spring steel reed. J-B-T meters on portable field equipment have established an enviable performance record.

J-B-T Vibrating Reed Frequency Meters are available for frequencies from 15 cycles to 400 cycles with various reed groupings, increments and case sizes. For additional facts on the complete line, send for your copy of Bulletin VF-43.

J-B-T

(Manufactured under Triplett Patents and/or Patents Pending)

4-JBT-1

J-B-T INSTRUMENTS, INC.

431 CHAPEL STREET • NEW HAVEN 8, CONNECTICUT

plates. Each rod is sealed to a glass tube passing through a hole in the steel plate which supports the gun, the seal being made with a gasket cut from small rubber tubing. Each of three of the tubes contains a 0.02 in. tungsten wire, one end of which emerges through the wall of the tube, near the butt joint to the glass rod; this wire acts as a lead for one of the focusing plates. The heat shield is grounded to the steel supporting plate by a nickel lead.

The first guns were unsatisfactory because the glass around the tungsten wires holding the focusing plates decomposed and became conducting under the influence of heat from the filament and the potentials applied to the focusing plates. This difficulty almost vanished when the tungsten wires sealed into the glass rods were cut off as close as possible to the rods and their ends covered with small blobs of glass spotted onto the rods.

One wire from each plate was left long and connected to one of the tungsten leads sealed into the supporting tubes. After prolonged use the gun would exhibit some leakage between the electrodes; it could be repaired by simply heating the glass rods in the neighborhood of the plates.

Plates

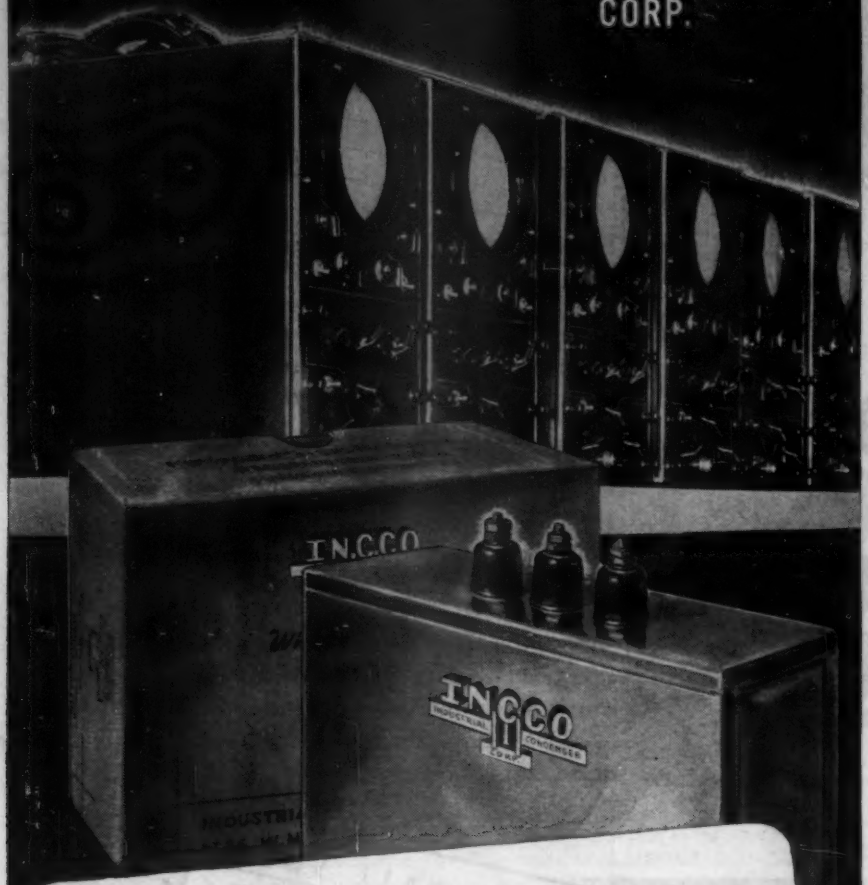
The heat shield, a cylinder of 0.01 in. stainless steel, is 1 in. long and 0.75 in. in diameter. The focusing plates are 1 in. in diameter, cut from 0.01 in. stainless steel sheet and made flat by pressing them between two steel blocks in a hydraulic press. For reference purposes the plate nearest the filament is called No. 1, the next No. 2, and the one nearest the target No. 3. There is a 0.375 in. hole at the center of No. 1, while No. 2 and No. 3 have 0.25 in. holes at their centers. A centrally located 0.6 in. glass tube holds a pair of 50-mil tungsten wires in a press seal; these support the filament and serve as leads to it.

This arrangement prevents the focal spot from "seeing" the filament, which is a single circular loop of oxide-coated perforated nickel strip 4 mm wide and 11 mm in diameter. It is mounted inside the heat shield, 1 mm from and coaxial with plate No. 1.

The gun operates satisfactorily

WORLD FAMOUS OSCILLOSCOPES by DUMONT

Use Capacitors by INDUSTRIAL CONDENSER CORP.



Capacitors used in Dumont's famous oscilloscopes are especially designed, engineered and manufactured for unusual performance under difficult operating conditions.

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with Plate No. 1 at 500 volts and No. 2 at 1100 volts positive with respect to the grounded filament. With No. 3 connected to No. 2 the cathode-rays form on the target a rather well-defined image of the filament, so that the focal "spot" is an annulus 1 mm wide and from 3 to 5 mm in outside diameter. Decreasing the potential of No. 3 reduces the size of the focal ring; with No. 3 grounded the diameter of the ring is 2 or 3 mm. These diameters depend to some extent on the target potential. The cathode-rays cross over near plate No. 1; therefore, the aperture in No. 2 could probably be made smaller if further screening of the target is necessary.

The tube operates satisfactorily with currents as high as 100 ma to the target. The current to plate No. 1 varies from 10 percent to 100 percent of the current to the target, depending on the age of the filament and the magnitude of the target current. The percentage of the emitted electrons collected by plate No. 1 decreases with increasing filament emission and increases with age of the filament. It also increases slightly with decreasing target voltage, especially below 10 kilovolts. This effect could be considerably reduced, if it were objectionable, by simply increasing the distance from the gun to the target. The current to plates No. 2 and No. 3 is of the order of 1 ma to both plates.

Operation

Since it was necessary to reduce to a minimum the contamination of the target, mercury diffusion pumps and a liquid-air trap were used and there were no wax joints in the tube other than a single wax seal in the lead between the tube and the pumps. The pressure as measured by an ionization gauge was about 1.2×10^{-5} mm of mercury when the tube was operating.

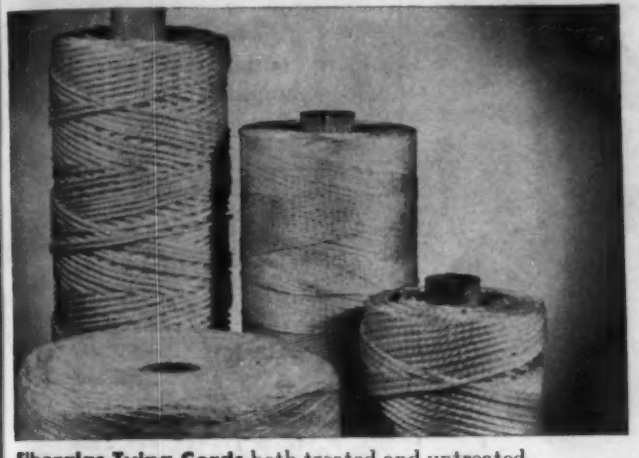
At first the tube contained enough foreign matter (presumably grease or oil) to contaminate a copper or silver target very badly in an hour or two. The target became discolored while simply sitting in the vacuum, even when the filament was cold. This difficulty was overcome by passing a rather violent discharge between the target and the tube body with the

FIBERGLAS* ELECTRICAL INSULATION NOW AVAILABLE!

(Increased Fiberglas Production permits this Announcement to be Made)

Fiberglas Tapes available in all widths and thicknesses from .003" to .015".

Fiberglas Braided Sleevings.



Fiberglas Tying Cords both treated and untreated.

A few of the many types of Fiberglas fabricated materials, including Fiberglas cloths, tapes, and tubings; Fiberglas-mica combination material and Fiberglas laminated sheets.

Not pictured but also available are: Unprocessed yarns, varnished tapes, cloths, sleevings, and saturated sleevings.

Owens-Corning Fiberglas Corporation, Toledo 1, Ohio.
Fiberglas Canada, Ltd., Oshawa, Ontario.

FIBERGLAS
*T. M. Reg. U. S. Pat. Off.

ELECTRICAL INSULATION

ARMY (E) NAVY

Get in Touch with Your Electrical Distributor Now! . . . Fiberglas Materials are in stock for immediate delivery!

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Ten channels: Galvanometers available covering wide range of characteristics: Daylight loading of 6-inch paper or film: Recording speeds quickly adjustable: Automatic record length control: Automatic record numbering: Simultaneous viewing and recording: All controls convenient on top panel. Early delivery. Hathaway Instrument Co., Denver, Colorado.

Write for Bulletin and Prices

Hathaway INSTRUMENTS

tube full of oxygen at a pressure of a few hundredths of a millimeter, and then using hydrogen in place of oxygen. The gas was flushed out and renewed every five minutes; about six changes of oxygen and three of hydrogen proved effective.

• • •

Feedback Amplifier

(*Continued from page* 131)

the factor $1/(1-A_v\beta)$ when negative feedback is applied. A_v is always less than μ in the practical case.

If the load resistance is connected to the vacuum tube, as indicated by the dotted lines of Fig. 8, the current I then becomes

$$I = \frac{E}{R_L} + \frac{E - \mu\beta E}{r_p}, \qquad (39)$$

and the output-impedance level Z'_0 of the amplifier and load circuit with feedback is

$$Z'_0 = \frac{E}{I} = \frac{E}{\frac{E}{R_L} + \frac{E - \mu\beta E}{r_p}}$$

$$= \frac{1}{\frac{r_p + (1-\mu\beta)R_L}{R_L r_p}} \qquad (40)$$

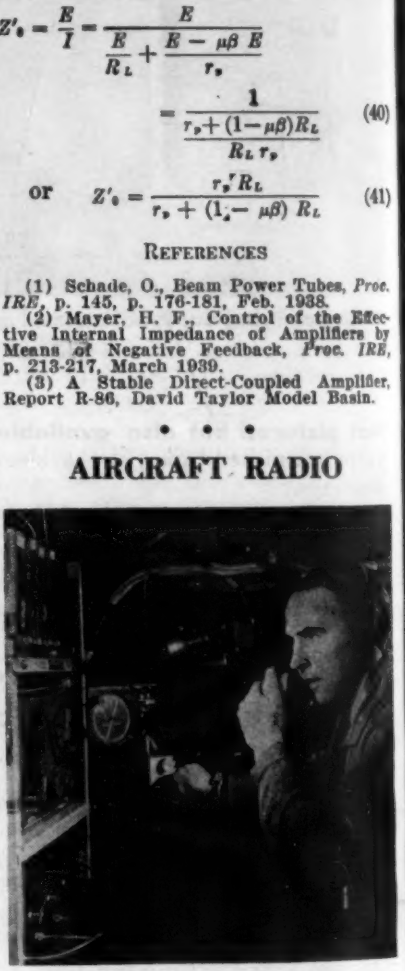
or $$Z'_0 = \frac{r_p' R_L}{r_p + (1 - \mu\beta) R_L} \qquad (41)$$

REFERENCES

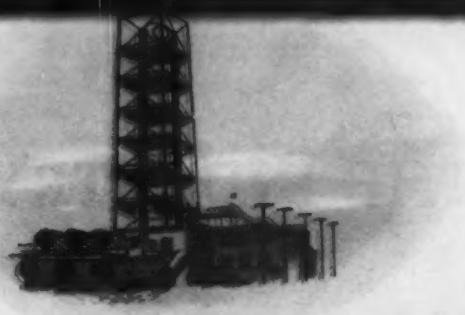
(1) Schade, O., Beam Power Tubes, *Proc. IRE*, p. 145, p. 176-181, Feb. 1938.
(2) Mayer, H. F., Control of the Effective Internal Impedance of Amplifiers by Means of Negative Feedback, *Proc. IRE*, p. 213-217, March 1939.
(3) A Stable Direct-Coupled Amplifier, Report R-86, David Taylor Model Basin.

• • •

AIRCRAFT RADIO



A highly selective receiver and several interchangeable transmitters in a multiple rack form the Western Electric command set used in both Army and Navy planes



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In a move of far-reaching significance to the entire plastic industry, Dow announces a reduction in the base price of Styron (Dow Polystyrene)—from 30 to 27 cents per pound. The new low price, at which you may now obtain this strategic plastic from its source, is made possible by improved and vastly increased production.

Current rubber needs for styrene—chemical antecedent of polystyrene—are, of course, of major importance today. But, Dow's ability to lower the price of polystyrene places this plastic in a price range favorable to greatly extended uses for which this outstanding thermoplastic material has proved peculiarly adaptable. It will undoubtedly affect the design and manufacture of literally thousands of products now and when Peace returns.

Complete Styron price lists are available on request.

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Write for New Dow Booklet "A Practical Approach to Plastics."

STYRON

(DOW POLYSTYRENE)

DOW PLASTICS

NEWS OF THE INDUSTRY

New FCC setup; television network in 1946; standards for electronic heating; Panel 13 activity; British television plan, Navy technical training; RMA standardization machinery

New Army-Navy Preferred List of Electronic Tubes

A NEW LIST of unclassified preferred general-purpose tubes, selected jointly by the Signal Corps and the Bureau of Ships, has been issued as of February 15, 1944, and supersedes the similar list dated March 1, 1943. All unclassified tubes to be used in all future designs of new equipments under the jurisdiction of the Signal Corps Laboratories or the Radio Division of the Bureau of Ships must be chosen from this list.

If tubes other than those included in the list are to be used in the design of new equipment, specific approval of the Service concerned must be obtained. Publication of the list is in no way intended to hamper or restrict development work in the industry.

The list now contains 70 types of receiving tubes, 51 transmitting types and 16 miscellaneous types. In the latter group are now included clipper, gas switching and crystal types.

New FCC Setup

EWELL K. JETT, chief engineer of FCC since January, 1938, and assistant chief engineer since 1929, took his oath of office as FCC Commissioner on February 15 and attended his first Commission meeting in that capacity the following day. With his assumption of duties, the FCC has, for the first time in nearly eight months, its full complement of seven members.

Commissioner Jett will continue in his capacity as chairman of the Coordinating Committee of the Board of War Communications and will also work closely with the interdepartmental communications post-war planning committee of the State Department. His post as chief engineer has been filled by the appointment of George P. Adair, former assistant chief engineer in charge of broadcasting, who will also replace Commissioner Jett as observer on the Radio Technical Planning Board.

Philip F. Siling, chief of the International Division of FCC, has been promoted to assistant chief engineer in charge of the Broadcast Division, and Marion H. Woodward, assistant chief of the International Division, has become chief of that Division.

ARMY-NAVY PREFERRED LIST OF RADIO ELECTRON TUBES

RECEIVING TYPES

Filament Voltage	Diodes	Diode Triodes	Triodes	Twin Triodes	Pentodes: Remote	Pentodes: Sharp	Converters	Power Output	Indicators	Rectifiers	Miscellaneous
1.4	*1A3*	1LH4	1LE3	*3A5* 3B7/1291	*1T4*	*1L4* 1LN5 *1S5*	1LC6 *1R5*	*3A4* 3D6/1299 *3S4*			Crystals IN21B
5.0										5U4G 5Y3GT	IN23 IN27
6.3	*6AL5* 6H6* 559 *9006*	6AQ6 6SQ7* 6SR7*	2C22 2C26 *6C4* *6J4* 6J5* 7E5/1201 *9002*	*6J6* 6SL7GT 6SN7GT	6SG7* 6SK7* *9003*	6AC7* *6AG5* 6AG7* *6AK5* 6SH7* 6SJ7* 7W7 *9001*	6SA7*	6G6G 6L6GA 6N7GT/G 6V6GT/G 6Y6G	6E5	6X5GT/G 1005	Phototubes 918 927
12.6	12H6*	12SQ7* 12SR7*	12J5GT	12SL7GT 12SN7GT	12SG7* 12SK7*	12SH7* 12SJ7*	12SA7*	12A6*	1629		Voltage Regulators OB3/VR-90 OC3/VR-105 OD3/VR-150
25 and above								25L6GT/G 28D7	991	25Z6GT/G	

TRANSMITTING TYPES

Triodes		Tetrodes	Twin Tetrodes	Pentodes	Rectifiers: Vacuum	Rectifiers: Gas	Rectifiers: Grid Control
2C26	801A	5D21	3E29	2E22	2X2	4B25	3C23
2C44	809	715B	815	803	3B24	83	3C31/C1B
6C21	811	807	829B	837	5R4GY	866A/866	C5B
15E	826	813	832A		371B	872A/872	884
VT127A	833A	814			705A		2050
327B	838	1625			836		
434A	1628				1616		
446A	8005				8016		
527	8014A				8020		
530	8025						

MISCELLANEOUS TYPES

Clipper Tubes	Gas Switching	Cathode Ray
73	1B32/832A	2AP1
719A	471A	3BP1
	532	3DP1
		3FP7
		5CP1
		5CP7
		5FP7
		5JP1
		7BP7
		12DP7
		12GP7

* Where direct interchangeability is assured "GT" and "L" counterparts of the preferred metal tubes may be used. Miniature tubes (shown in Italics) shall be used only when essential to Service requirements.

Veteran in Search of a Peacetime Future

THIS veteran knows of no job to come back to after the war.

It was born of war necessity—built to perform a strategic purpose new in the history of aircraft.

The requirements were an engineering challenge. It had to be strong to do its heavy work. Yet it had to be light and fit in the small space available.

That is why even optimists doubted such a device could be built.

But here it is: The Lear Actuator.

Its job is operating flaps, landing gears, shutters and other equipment on the power of an airplane storage battery.

Now, of course, our plants are working round the clock to make enough of these for the fighting ships of Uncle Sam.

But we know that such unique devices, the midget motors that drive them and all the 250 Lear products, must have an important future in some peacetime products.

They may park your car with the push of a button—or do any of thousands of jobs we haven't thought of.

That is why we are telling you about them. We want to find jobs for these able veterans.

And we want you to know that the kind of engineering thinking and production technique that made them possible is available.

PLANTS: Piqua, O., and Grand Rapids, Mich. BRANCHES AT: New York, Los Angeles, Chicago, Detroit, Cleveland, Providence.

LEAR AVIA INC.
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Designed for Application

THE 37212 PLUG

Designed for Application! Compact, easy to use. Made in black and red regular bakelite as well as low loss brown mica filled bakelite for R.F. uses. Small circular depression on top for "color coding" or polarity indication. Designed primarily for use with our No. 37222 captive head posts and No. 37202 plates.

(Standard ¾" spacing)

JAMES MILLEN MFG. CO., INC.

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Checking Electronic Autopilot

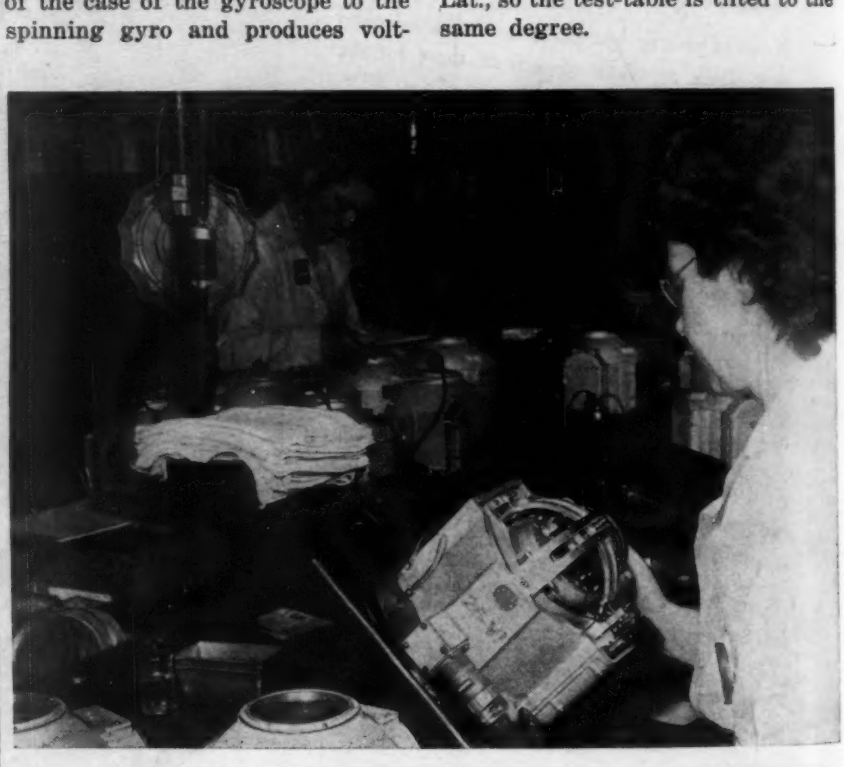
The turn control of the autopilot is checked against servo motors on the table before the instrument is shipped to plane plants for installation

CAPABLE of making over 300 flight corrections per minute, the Minneapolis-Honeywell autopilot holds Army bombers on the correct course during high-altitude bombing runs. At the height flown, an error of one mil would cause the bomb to miss the target by 360 feet or more.

Heart of the system is the gyroscope that maintains an upright position at all times during the course of a plane's flight. Movement of the plane changes the relative position of the case of the gyroscope to the spinning gyro and produces voltages that are amplified by electronic tubes and fed to servo motors that adjust flying controls to maintain a fixed flying attitude.

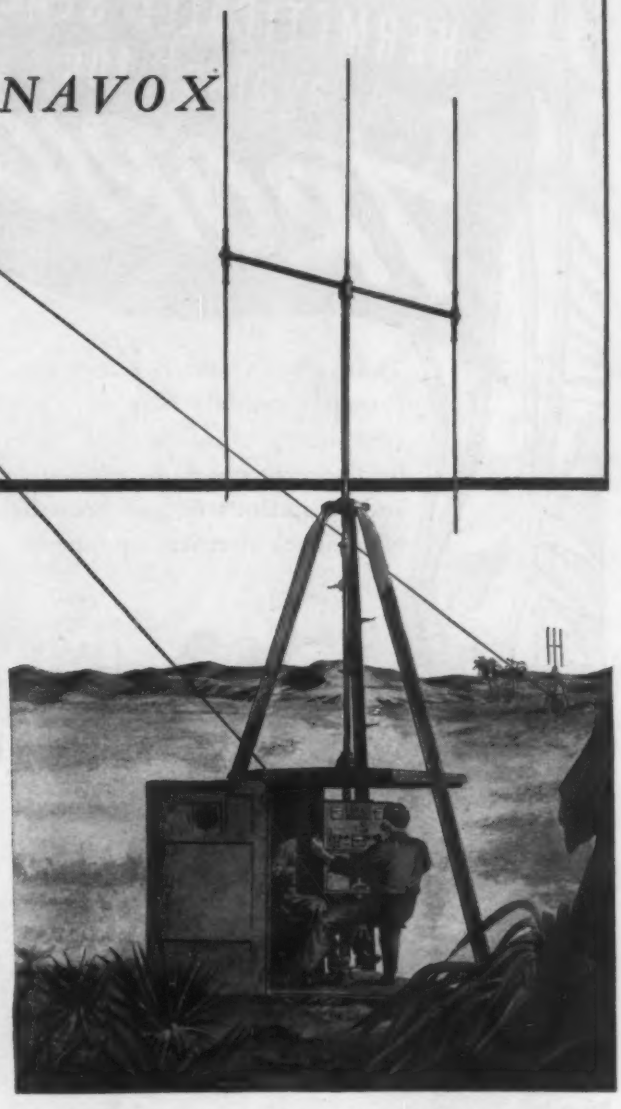
The photos show steps in the manufacture of the gyroscope for the electronic system. The degree of mechanical tolerance necessary in construction is indicated by the fact that the rotor must be oiled with only one drop of oil from a hypodermic needle.

The plant is located at 45° N. Lat., so the test-table is tilted to the same degree.



A special "tilt-table" is used to hold the spinning gyroscope so that the instrument is exactly parallel to the earth's axis

POSTWAR RADIO INDUSTRY WILL FIND MAGNAVOX ON THE BEAM

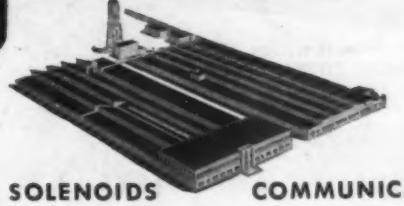


MAGNAVOX was well prepared for its important wartime role, having made many technical contributions to the radio industry during thirty-three years of pioneering.

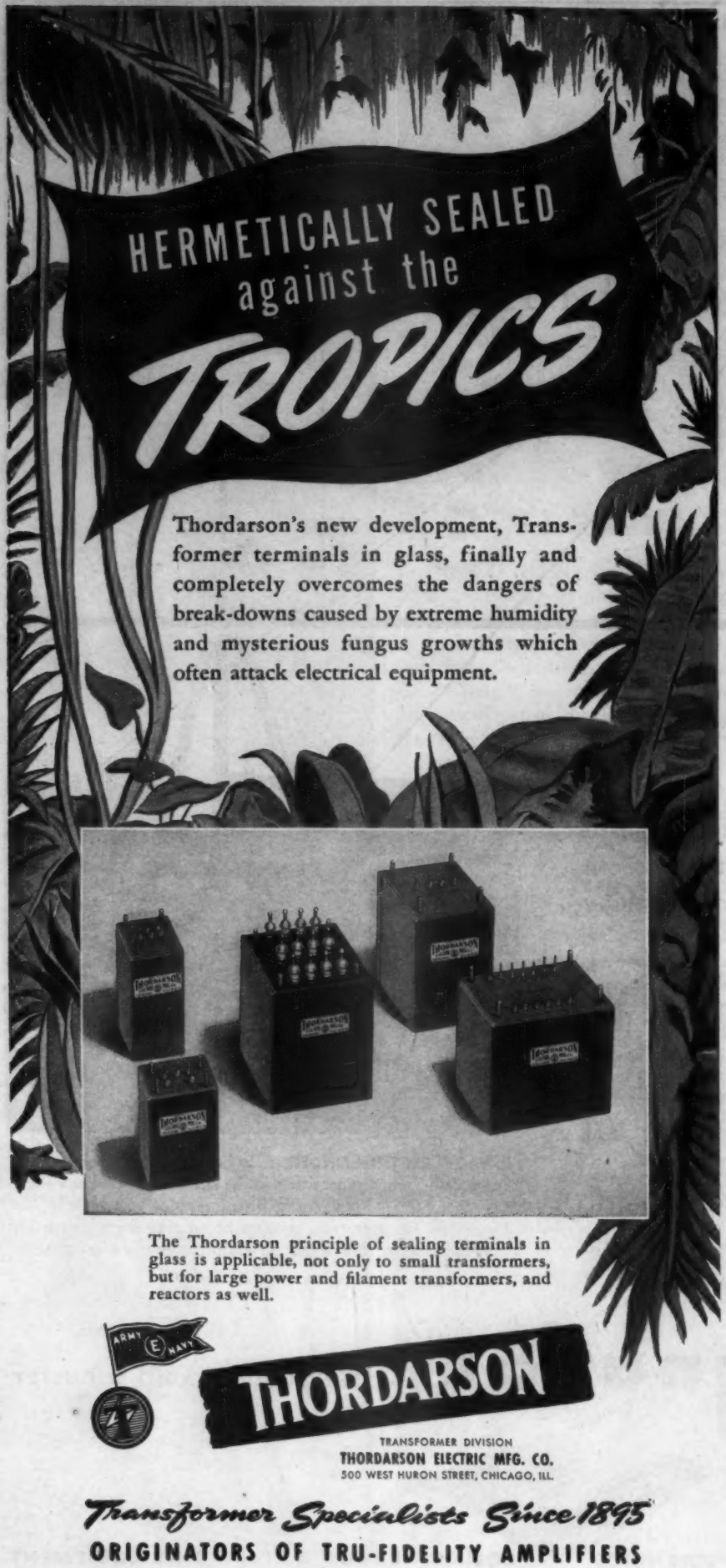
This wartime experience, in turn . . . designing, developing, manufacturing . . . prepares Magnavox to contribute even more in the peacetime developments to come, in all phases of electronics. Our skills and the excellent facilities of the new, modern six-acre plant will be ready, at the very peak of their efficiency. The Magnavox Company, Fort Wayne 4, Indiana.

RADIO DIRECTION FINDERS help bring our fliers home safely, and locate enemy transmitters in the air, at sea or on land. These are among the many scientific instruments of war made by The Magnavox Company . . . equipment ranging from gun firing solenoids to the most intricate radio communication systems.

FOR 33 YEARS **Magnavox** HAS SERVED THE RADIO INDUSTRY



LOUD SPEAKERS • CAPACITORS • SOLENOIDS COMMUNICATION & ELECTRONIC EQUIPMENT


HERMETICALLY SEALED
against the
TROPICS
Thordarson's new development, Transformer terminals in glass, finally and completely overcomes the dangers of break-downs caused by extreme humidity and mysterious fungus growths which often attack electrical equipment.
The Thordarson principle of sealing terminals in glass is applicable, not only to small transformers, but for large power and filament transformers, and reactors as well.
ARMY E NAVY
THORDARSON
TRANSFORMER DIVISION
THORDARSON ELECTRIC MFG. CO.
500 WEST HURON STREET, CHICAGO, ILL.
Transformer Specialists Since 1895
ORIGINATORS OF TRU-FIDELITY AMPLIFIERS

Standards for Induction and Dielectric Heating

THE ELECTRONICS SECTION of National Electrical Manufacturers Association has adopted standards for electronic equipment for dielectric and induction heating.

The complete text of the new standards follows:

EL 5-5 Output Ratings

The following output ratings for Electronic Induction or Dielectric Heating Units shall be considered as preferred:

0.5 kw	20.0 kw
1.0 kw	50.0 kw
2.0 kw	100.0 kw
5.0 kw	200.0 kw
10.0 kw	

These ratings are recommended until there is need for intermediate sizes. *Suggested Standard for Future Design 1-18-44.*

EL 5-10 Ratings Of Tubes And Parts

Electronic tubes and other component parts of electronic induction or dielectric heating units shall be used within the manufacturer's ratings. *Recommended Standard 1-18-44.*

EL 5-15 Radio Interference

Electronic induction or dielectric heating apparatus shall be so designed and installed as to minimize radio interference. *Recommended Standard 1-18-44.*

EL 5-20 Protection Of Personnel

Electronic induction or dielectric heating apparatus shall include provisions for protecting the operating personnel against dangerous voltages. *Recommended Standard 1-18-44.*

EL 5-25 Protective Equipment.

Installations of electronic induction or dielectric heating apparatus should include protective equipment such as fuses, relays and/or circuit breakers, acting to disconnect the apparatus from the supply line in case of failure or flashover of internal components. *Recommended Standard 1-18-44.*

EL 50-5 Induction Heating—Definition

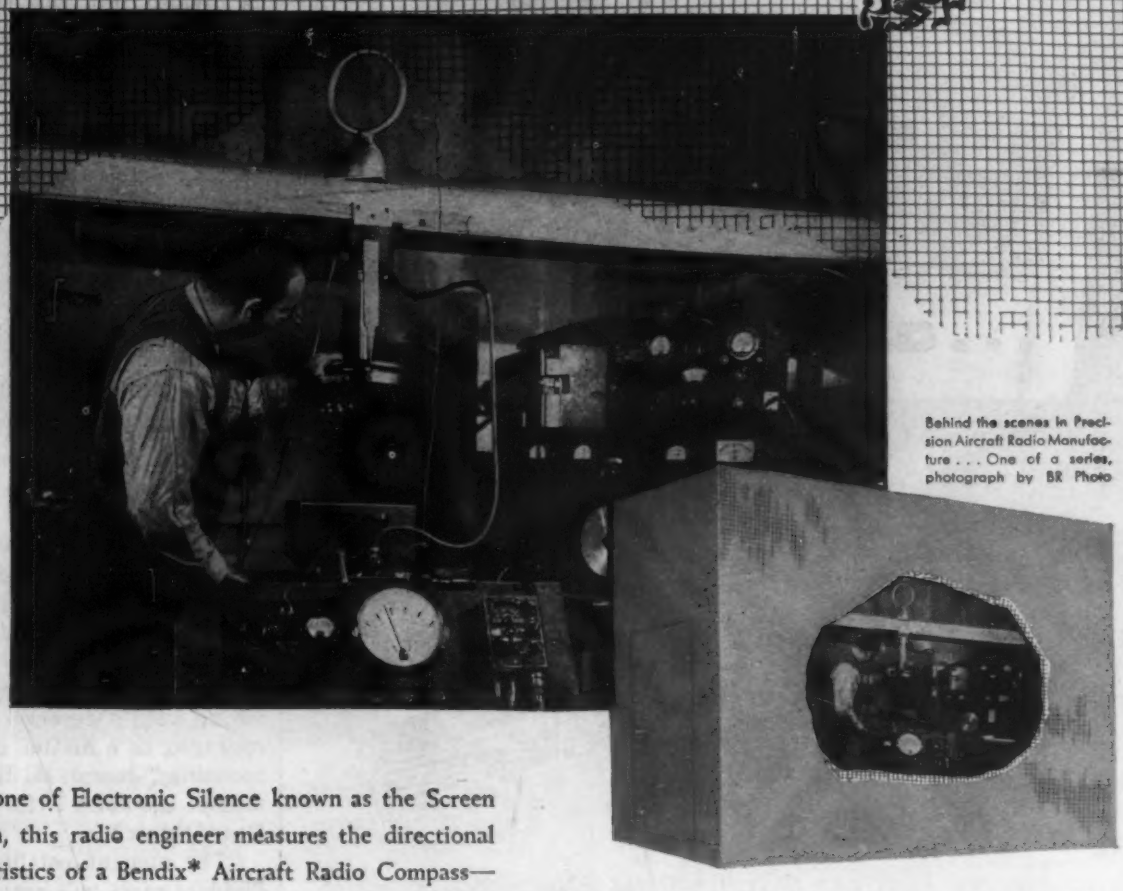
Induction heating is the heating of a nominally conducting material due to its own I^2R losses when the material is placed in a varying electromagnetic field. *Adopted Standard 1-18-44.*

El 50-10 Dielectric Heating—Definition

Dielectric heating is the heating of a nominally insulating material due to its own dielectric losses when the material is placed in a varying electric field. *Adopted Standard 1-18-44.*

The NEMA has also issued a

Keeping out the "Bugs"



Behind the scenes in Precision Aircraft Radio Manufacture . . . One of a series, photograph by BR Photo

IN a Zone of Electronic Silence known as the Screen Room, this radio engineer measures the directional characteristics of a Bendix* Aircraft Radio Compass—completely surrounded by double walls of bronze mesh, soldered and grounded to keep out all electronic interference. No electronic "bugs" can creep in to disturb the test readings during these meticulous and intricate adjustments . . . for on their accuracy a pilot's life may one day depend.

The ideal conditions of the Screen Room represent but one of several thousand tests and inspections established at Bendix Radio. Bendix Engineers also create extremes of substratospheric cold and low pressure, tropical heat and humidity, atmospheric interference and static . . . as well as combat strain and landing shock . . . so that radio equipment engineered and manufactured under the Bendix name will more than meet the rigors of war service.

Every step in production is guarded by these tests . . . from individual components and sub-assemblies to the compact, finished, aircraft radio you see being tested in the Zone of Electronic Silence. It is this insistence upon quality and precision that builds dependable performance into the equipment Bendix Radio has pioneered for the airlines and our nation's armed forces.

THE INVISIBLE CREW
Precision Equipment by Bendix Aviation Corporation

*TRADE MARK OF BENDIX AVIATION CORPORATION.

BENDIX RADIO

BENDIX RADIO DIVISION OF THE BENDIX AVIATION CORPORATION
BALTIMORE, MARYLAND

FOR THE ARMY AND NAVY, the David Bogen Company is intensifying production of vital intercommunication, detection and specialized sound distribution equipment.

For Bogen distributors, we're working steadily to catch up with the demand for Bogen catalog equipment. It's equipment that's doing a mighty important war job, too. Delivery dates are being kept more regularly. What's more, they are going to be better.

We illustrate the Bogen Model E75, unquestionably one of the finest High Power Amplifiers ever manufactured to commercial specifications. Under wraps, as a matter of military secrecy, are the many wartime Bogen developments in sound equipment. These developments will be released after Victory for incorporation in great new Bogen equipment which will spell profit and prestige to our distributors—and a better life for a world at peace.

BUY MORE WAR BONDS AND STAMPS

David Bogen Co. Inc.

THE STANDARD OF PERFORMANCE

663 BROADWAY NEW YORK 12, N. Y.

Bogen Sound Systems • Commune-Phones • Amplifiers • Electronic Equipment

manual for the guidance of members in dealing with contract terminations. This contains a check list of the steps which all prime and sub-contractors should take in the preparation and conduct of contract terminations. The check list is divided into the following six major divisions: preparation of claims; reviewing of contractual relationships; establishment of proper internal organization for handling terminations; checking of company status and financial policies; planning production control problems; and reviewing of contractual relationships.

Renegotiation Refunds

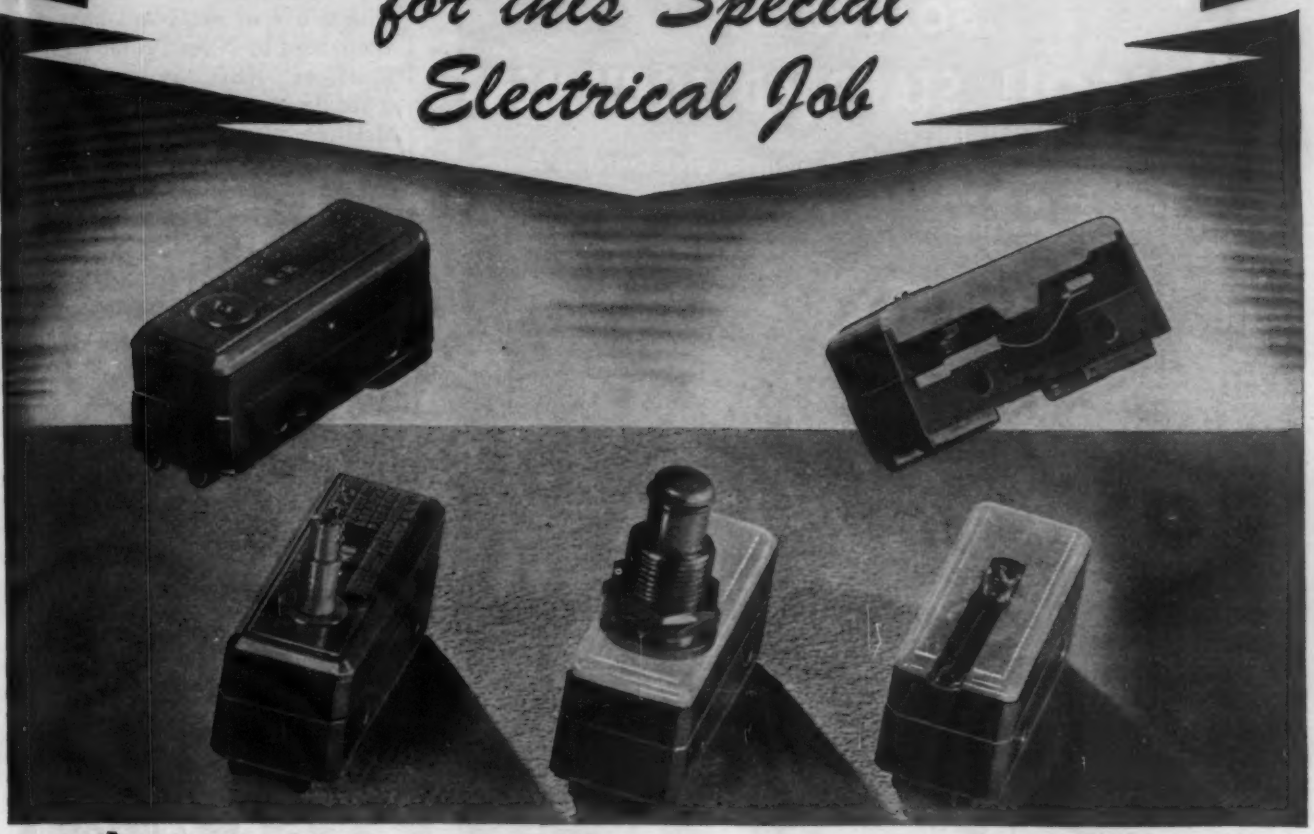
According to a ruling by the Joint Price Adjustment Board, reserves for renegotiation refunds which war contractors may set up and show in their statements and annual reports are not to be regarded by Government renegotiation officials as binding on contractors.

"The increasing practice of providing such a reserve is to be encouraged as a matter of sound accounting," Joseph M. Dodge, chairman of the Joint Price Adjustment Board, stated.

"The amount established in individual cases will vary widely, depending upon the policy of the particular contractor. It may be more or less than is actually needed when the renegotiation of the fiscal year for which the reserve has been set up is concluded. It would be manifestly unjust for the contractor to be bound by the amount of any reserve he may have created or for the existence of the reserve or the amount of it to affect the renegotiation procedings. The renegotiation officials are instructed that such reserves are not to be considered directly or indirectly in connection with the determination of any price adjustment to be refunded to the Government under the terms of the renegotiation statute."

The six Federal renegotiation agencies represented by the Board are: War, Navy and Treasury Departments, the U. S. Maritime Commission, the War Shipping Administration, and the Reconstruction Finance Corporation.

This is why Plaskon was chosen for this Special Electrical Job



America's great fleet of airplanes . . . Army . . . Navy . . . commercial . . . private . . . is extensively equipped with color-coded Micro Switches. Color-coding is accomplished by the use of Plaskon Molded Color, which is formed into the switch-cover plates so important in all airplane operating and control systems.

Plaskon was chosen for the production of Micro Switches because it is hard and tough, holds its shape, and molds to exact dimensions. It permits precision machining to 1/1000 of an inch limits, which is essential because of the extreme accuracy with which Micro Switches must operate. Each permanent, non-fading Plaskon color indicates a definite aircraft control operation. And fully as important, is the fact that irrespective of weather conditions these parts are electrically non-tracking and arc resistant.

These are the advantages of Plaskon Materials for Electrical Designing:

Plaskon Urea-Formaldehyde Compound

1. Wide range of lightfast hues, from translucent natural and pure white to jet black.
2. Smooth surface, eye-catching, warm to touch.
3. Completely resistant to common organic solvents, impervious to oils and grease.
4. Possesses extremely high flexural, impact and tensile strength.
5. Highly resistant to arcing and tracking under high voltages and high frequencies.

Plaskon Grade 2 Compound

1. A Plaskon urea-formaldehyde of good quality, lower in price than regular Plaskon, and adaptable to economy production requirements.
2. High resistance *to*, and retains lustre, surface and color *in*, presence of water, common organic solvents, soaps, etc.
3. Identical unusual dielectric strength and freedom from arcing and tracking as regular Plaskon.

Furnished in one shade of black and brown only.

Plaskon Melamine Compound

1. Assures ample protection where water or high humidity prevent the use of urea compounds.
2. Exceptional resistance to acids and alkalies. Non-porous, non-corrodible.
3. Under extreme conditions of heat and humidity, is non-tracking, highly resistant to arcing, and has high dielectric strength.
4. Highest heat resistance of all light-colored plastics.

Plaskon Resin Adhesive

1. Materials bonded by Plaskon Resin Glue cannot be separated at glue line—the material fails first.
2. Plaskon glue line is completely moisture-resistant, cannot be weakened by mold or fungi.
3. Maintains its tenacious grip in heavy-duty service for years, under water, on land, in the air.

PLASKON DIVISION • LIBBEY•OWENS•FORD GLASS COMPANY
2136 SYLVAN AVENUE • TOLEDO 6, OHIO

Write for this Manual

The properties and characteristics of Plaskon in molded form, and the proper methods of fabrication, are discussed in detail in this valuable Plaskon handbook. Its contents will be of interest to engineers and fabricators alike.

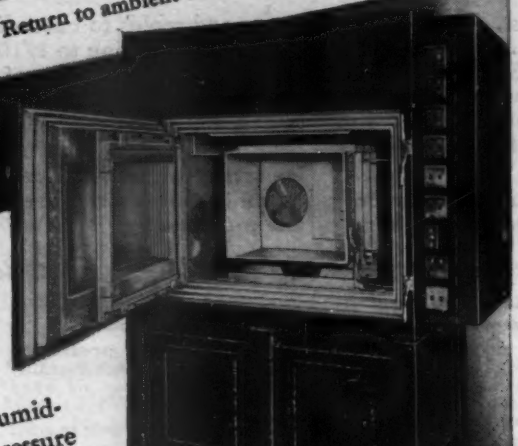
PLASKON
TRADE MARK REGISTERED
*** * MATERIALS * ***

Special TESTING PROBLEMS SOLVED BY AMCOIL STANDARD EQUIPMENT

Recently, an electronic instrument manufacturer found in American Coils Company's standard equipment, his answer to a particularly difficult test run

PROBLEM

1. Simulate an altitude of 30,000 feet at room temperature.
2. Return to atmospheric pressure and hold at 40° C. and 30% relative humidity for 30 minutes.
3. Change to 95% relative humidity and hold constant for 1 hour.
4. Return to 30% relative humidity and hold for 30 minutes.
5. Hold for 12 to 18 hours at 25° C. and 50% relative humidity.
6. Reduce to —65° C. and hold for 1 hour.
7. Simulate 55,000 feet altitude at no change in temperature.
8. Return to +70° C. and atmospheric pressure and remain constant for 2 hours.
9. Return to ambient conditions.



Answer

Model RAC 2AA with humidity attachment and a pressure range of from sea level to 70,000 ft., solved this problem with ease. A cross ambient control prevents overshooting at humidities and temperatures close to room conditions.

Send your test problems to American Coils Co., and see if they are not covered by standard equipment. If not, Amcoil's engineers are available for consultation.

AMCOIL

AMERICAN COILS CO.

25-27 LEXINGTON STREET • NEWARK, N. J.

Coast-to-Coast Television by 1946

PLANS FOR THE COMPLETION of a coast-to-coast television network within five or six years have been announced by Niles Trammell, president of NBC, in releasing a schedule received from Keith S. McHugh, vice-president of AT & T, outlining the proposed installation of coaxial cable for transmission of television signals over long distances.

The schedule, contingent on the war and other considerations, shows the following dates for installation of the portions of the proposed cable links:

1945—New York-Washington
1946—New York-Boston; Washington-Charlotte; Chicago-Terre Haute-St. Louis; Los Angeles-Phoenix
1947—Chicago - Toledo - Cleveland-Buffalo; part of the southern transcontinental route including Charlotte-Columbia - Atlanta - Birmingham - Jackson-Dallas-El Paso-Tucson-Phoenix
1948-'50—Completion of southern transcontinental route; Washington-Pittsburgh-Cleveland; St. Louis-Memphis-New Orleans; Kansas City-Omaha; Des Moines-Minneapolis; Atlanta-Jacksonville-Miami; Los Angeles-San Francisco

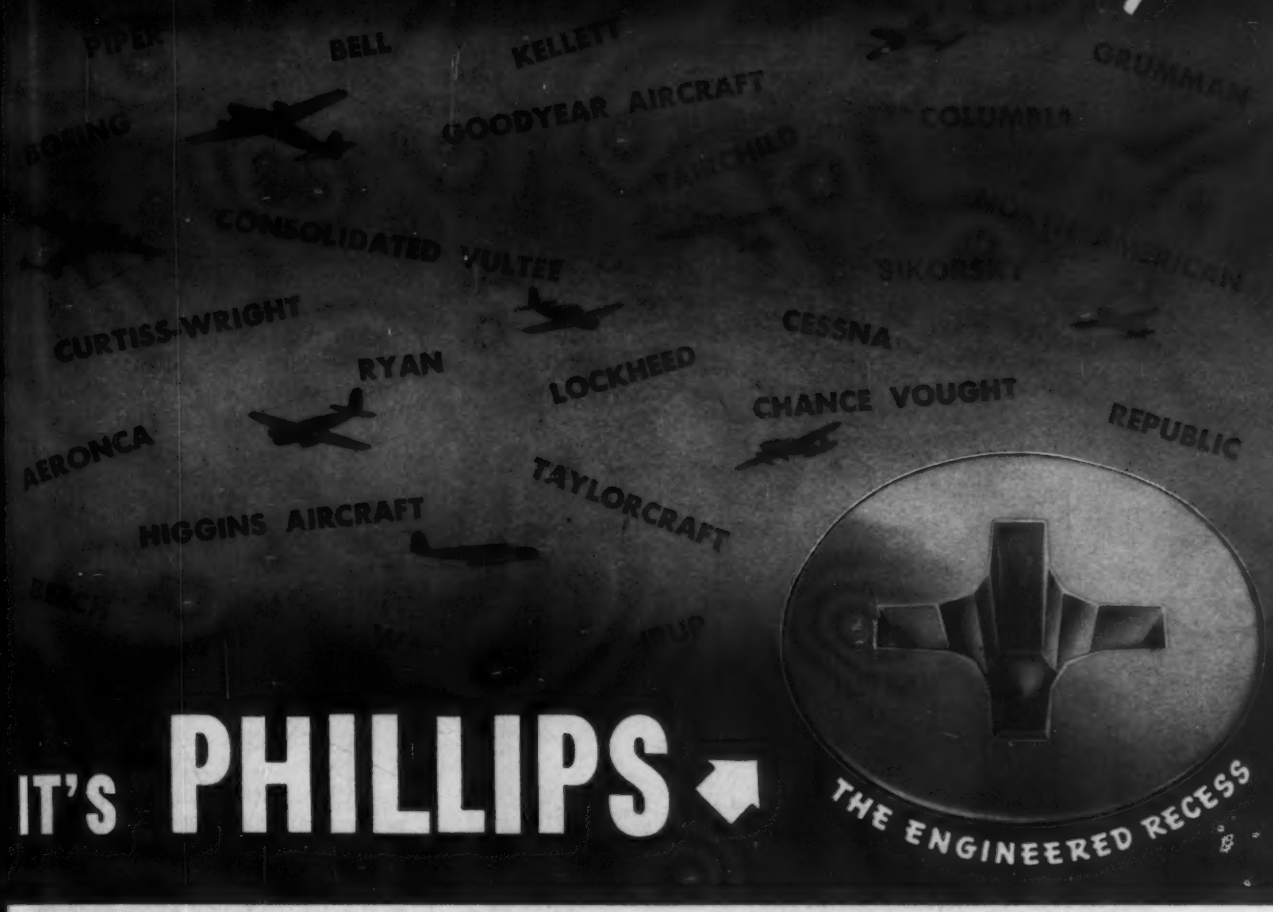
Two coaxial cables are now in operation. One links New York and Philadelphia, and another connects Minneapolis and Stevens Point, Wisc. The former was first used for television broadcasts from the Republican National Convention in 1940, and the latter is used for experimental programs.

NBC also plans to construct a television station in Washington to be used to transmit programs to WNBT, the NBC outlet in New York City. This will be built when materials become available and when the AT & T coaxial transmission line between the two cities is completed.

RTPB Panel 13 Meeting

SEVENTY-FIVE RADIO ENGINEERS and delegates representing police and five departments, forestry and conservation, power utilities, transit utilities and railroads, gathered in a two-day meeting in Chicago in January to discuss full organizational plans. The meeting was held in response to a nationwide invita-

Which RECESSED HEAD SCREW DOES THE AVIATION INDUSTRY *Okay?*



IT'S GOT TO BE RIGHT! The aviation industry knows its engineering . . . knows the answers to production efficiency. That's why most of the leaders in this industry selected the PHILLIPS Recessed Head.

You'll choose the Phillips Recess, too, once you study its exclusive design. You'll appreciate the scientific engineering that makes it so successful. You'll discover that every angle, every dimension has a purpose – is important to screw driving efficiency and screw strength. You'll agree there's nothing like it!

To end the screw driving troubles that slow down production and shove up assembly costs, specify screws with the Phillips Recessed Head. You can get them in any head style, type or size.

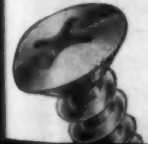
TO MAKE WARTIME QUOTAS AND PEACETIME PROFITS

FASTER STARTING: Driver point automatically centers in the Phillips Recess . . . fits snugly. Fumbling, wobbly starts, slant driving are eliminated. Work is made trouble-proof for green hands.

FASTER DRIVING: Spiral and power driving are made practical. Driver won't slip from recess to spoil material or injure worker. (Average time saving is 50%.)

EASIER DRIVING: Turning power is fully utilized. Workers maintain speed without tiring.

BETTER FASTENING: Screws are set-up uniformly tight, without burring or breaking of screw heads. The job is stronger, and the ornamental recess adds to appearance.



PHILLIPS *Recessed Head* SCREWS

WOOD SCREWS · MACHINE SCREWS · SELF TAPPING SCREWS · STOVE BOLTS

IDENTIFY IT!

Center corners of Phillips Recess are rounded . . .
NOT square.

Bottom of Phillips Recess is nearly flat . . .
NOT tapered to a sharp point.

23 SOURCES

American Screw Co., Providence, R. I.
The Bristol Co., Waterbury, Conn.
Central Screw Co., Chicago, Ill.
Chandler Products Corp., Cleveland, Ohio
Continental Screw Co., New Bedford, Mass.
The Corbin Screw Corp., New Britain, Conn.
General Screw Mfg. Co., Chicago, Ill.
The H. M. Harper Co., Chicago, Ill.
International Screw Co., Detroit, Mich.
The Lamson & Sessions Co., Cleveland, Ohio
Milford Rivet and Machine Co., Milford, Conn.
The National Screw & Mfg. Co., Cleveland, Ohio
New England Screw Co., Keene, N. H.
The Charles Parker Co., Meriden, Conn.
Parker-Kalon Corp., New York, N. Y.
Pawtucket Screw Co., Pawtucket, R. I.
Pheoll Manufacturing Co., Chicago, Ill.
Reading Screw Co., Norristown, Pa.
Russell Burdsall & Ward Bolt & Nut Co., Port Chester, N. Y.
Scovill Manufacturing Co., Waterville, Conn.
Shakeproof Inc., Chicago, Ill.
The Southington Hardware Mfg. Co., Southington, Conn.
Whitney Screw Corp., Nashua, N. H.

Makepeace

Laminated Precious Metals

FOR more than fifty years we have specialized in sheet, wire and tubing of precious metals, laminated on base metals, to secure the chemical and electrical properties of the one with the strength and resilience of the other. Thus, gold on phosphor bronze for tarnish proof and fixed quality bursting discs; silver alloys on nickel-silver or brass for contact parts, collector rings, etc.

We supply too, all precious metals in solid form and non-ferrous base metals to close tolerances and manufacture them into sheet down to .003" thick and in widths up to 4"; wire to .009" diameter and tubing from .015" to 1½" outside diameter with wall thicknesses from .004" upward. We also make fancy and special shapes and parts from them to your specifications.

D. E. Makepeace Company

ATTLEBORO, MASS.

tion to convene that was issued jointly by D. E. Noble, chairman of the Radio Technical Planning Board's Panel 13 on Portable, Mobile and Emergency Service Communication, and Frank W. Walker, vice-chairman of the Panel and alternate representative of International Association of Chiefs of Police.

Chairman Noble set the keynote of the Panel's work by explaining the need for viewing the frequency assignment, allocations and engineering problems on the basis of service requirements with a distinct realization of the practicability of application as compared to an idealistic engineering approach. William N. Krebs, chief of Safety and Special Services Division of FCC, spoke on the importance of postwar planning.

The Panel adopted a workable plan involving a Steering Committee, composed of the Chairmen of eight committees assigned to special tasks, who would meet with the administrative group; chairman, vice-chairman and secretary. To complete the executive officer appointments, the meeting selected Ero Erickson of APCO, member of the Illinois State Police, Chicago, as permanent Panel 13 secretary.

Agreement was reached on the operation of the Steering Committee which would allow each committee chairman to become an ex-officio member of the Engineering Committee in order to assure closest practicable inter-locking of all of the related engineering problems. The Engineering Committee would be called upon to supply appropriate consultant engineers to assist other committees not completely staffed with technical representatives.

Robert L. Batts, Chairman of Committee #1, announced that due to the great size of the police radio problem, his group would be further divided into sub-committees working on municipal, county, state and radiotelegraph communication reports. He also revealed arrangements would be completed with IACP to distribute a comprehensive radio survey questionnaire addressed to all Police Chiefs, Sheriffs and State Police Superintendents, to obtain information required by the Police Radio Communication Systems Committee. As a contributing sponsor of the RTPB which

For ten years Micro Switch has been a leader in the development, throughout industry, of automatic electrical control. The war program drafted Micro Switches for use in almost every type of fighting and radiation equipment on land, on sea, and, most of all, in the air. It put them into production lines where the implements of war are being built.

Fast-moving action, interesting color, and the concise description of "Uses Unlimited" convey the grippingly romantic story of how Micro Switches are made. It shows the myriad ways this tiny switch serves to control everything from sensitive, precise instruments and office equipment, to ponderous shop machines.

This film is packed with examples of tried and proven applications of Micro Switches which will stimulate every engineer to new conceptions of uses for compact, lightweight, precise, long-lived, trouble-free, electrical controls.

"Uses Unlimited" is available to industrial groups, training classes, schools and colleges. Size: 16 mm. Length: thirty minutes. Write us for details.

ARMY E NAVY

Micro Switch Corporation, Freeport, Illinois • Branches: 43 East Ohio Street, Chicago (11) • 4900 Euclid Avenue, Cleveland (3) • 11 Park Place, New York City (7) • 1709 W. 8th St., Los Angeles (14) • Sales & Engineering Offices: Boston • Hartford

LET'S ALL BACK THE ATTACK
BUY EXTRA WAR BONDS

The trademark MICRO SWITCH is our property and identifies switches made by Micro Switch Corporation

© 1944

MICRO MS SWITCH

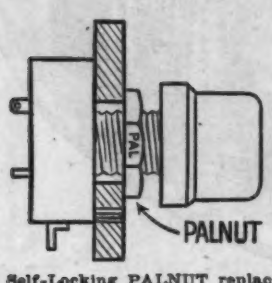
TRADE MARK

Made Only By Micro Switch Corporation . . . Freeport, Illinois, U.S.A.

Use ONE Self-locking PALNUT

instead of

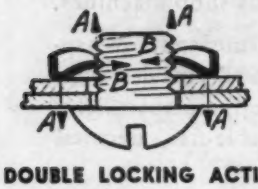
Two-piece fastenings!



A Self-Locking PALNUT replaced heavier, more expensive jam nut and lockwasher on this volume control, saving weight and cost.

By using a Self-Locking PALNUT in place of a regular nut and lockwasher, you immediately cut cost of fastenings in half—reduce assembly time 50%—save up to 90% in weight—require less space. At the same time, PALNUTS keep parts tight under severe vibration.

Self-Locking PALNUTS are single thread, spring tempered steel locknuts, requiring only 3 screw threads space. They apply with an ordinary wrench—or, on fast moving assembly lines, with Yankee or Power Drivers. When tightened, their powerful double locking action* holds parts tight under vibration. Available in a wide range of types, sizes, finishes and materials. Send details of assembly for samples. Write for Palnut Manual No. 2 giving data on principle, advantages, application, types, sizes, etc.



*** DOUBLE LOCKING ACTION**

When the PALNUT is wrench-tightened, its arched, slotted jaws grip the bolt like a chuck (B-B), while spring tension is exerted upward on the bolt thread and downward on the part (A-A), securely locking both.

THE PALNUT CO., 77 Cordier St., Irvington, 11, N. J.

involves a supporting expenditure of $1,000, IACP is keenly interested in bringing home to all of the nation's police departments the vital importance of immediate postwar planning of radio communication requirements.

Magnetic Wire Recorder On Bougainville

SERGEANT Roy Maypole, combat radio reporter, recorded interviews with Marines as they returned from forward assault positions on Cape Torokina, Bougainville. He used a portable magnetic wire recorder of a type being manufactured by General Electric for the armed forces, under license from Armour Research Foundation at the Illinois Institute of Technology. The men interviewed were in the initial landing at Empress Augusta Bay.

Official U. S. Marine Corps Photo

The recording was flown to Washington and made available to the radio networks. Mutual and Columbia carried portions of the recording recently.

Plan for British Television Network

A TELEVISION NETWORK, covering 85 percent of Britain's homes and which could operate nine months after the war, has been suggested and put before the Government Committee on Television.

The scheme suggests setting up 13 television diffusion stations, each relaying programs from a BBC main station, to which they would be linked either by radio or land line.

According to the London *News*

LIQUID
ROLL
ROLL CLOTH
This diagram is simplicity — reductio ad absurdum. No resemblance to the complicated machinery in our plant but the idea is to soak, to press in, to squeeze out — that's
IMPREGNATING
DOCTOR BLADE
ROLL
FILLING MIX
ROLL CLOTH
The filling is surface-spread, then scraped off at thread level, leaving a filing between the threads — variations through differing types of filler complicate the process and modify the result. That's a rough idea of
FILLING
DOCTOR BLADE
PLASTIC MASS
BASE PLATE
ROLL CLOTH
Imagine a plasterer spreading a finish coat on a wall and smoothing it out. Substitute cloth structure for lath base and various forms of plastic mass in place of plaster — and you have a rough idea of coating. Cloth is the structure concealed by the
COATING

3 STEPS TO BROADER FIELDS OF USEFULNESS

Cloth is not finished, it has not passed its last frontier. Coupled with the science of chemistry and the magic of plastics, cloth is definitely in the material picture of postwar planning. Only woven cloth affords structural and tensile strength with extreme durability and flexibility. Cloth drapes, folds, creases, bonds, reinforces, protects, decorates.

FILLING

In the three major steps of specialized cloth treatment, *Impregnating, Filling, and Coating* — filling means closing the interstices between the woven strands sealing the cloth and making it a barrier to the passage of light, air, gases, moisture, etc. Filling may or may not change the appearance of the fabric or affect its natural qualities. Its variations are endless.

We start with cloth and, through knowledge of processing, plus adequate research facilities, add special properties for special needs.

CURRENT HOLLISTON PRODUCTION includes COATED AND IMPREGNATED FABRICS . . . INSULATING CLOTH BASE . . . SEPARATOR CLOTHS rubber, starch-filled, glazed. TRACING AND BLUE PRINT CLOTHS white and blue, ink or pencil. MAP CLOTH, PHOTO CLOTH, self-adhesive. REINFORCING FABRICS. SIGN, LABEL AND TAG CLOTHS, waterproof to take any ink, meet any inking problem. BOOK-BINDING CLOTHS. SHADE CLOTH, impregnated waterproof, opaque, translucent or light proof.

We urge you to consider CLOTH; and invite you to consult with us concerning possibilities and developments for your specific requirements.

The Holliston Mills, Inc.
PROCESSORS OF CLOTHS FOR SPECIAL PURPOSES
NORWOOD, MASSACHUSETTS
Sales Agents in Principal Cities

Dependable Power..

Probably the most important single factor in modern warfare is complete, dependable communications. Dependable communications require a dependable power supply. Pincor is proud of its part in furnishing portable gasoline-driven and other electrical power supply units to the fighting front as well as to the home front.

Look to Pincor for your postwar needs in power plants, motors, converters and battery chargers.

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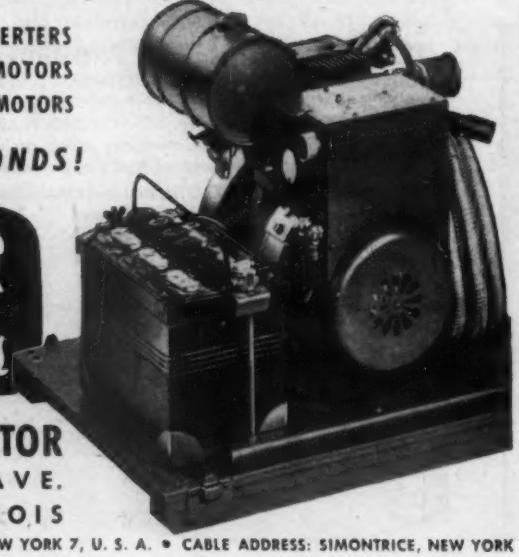
BUY WAR BONDS!



PINCOR Products

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Chronicle, a member of the Television Commercial and Development Committee said, "We aim to give employment to all those in the industry and in the Services who have been working on radio and television devices during the war.

"Developments due to war designs have shown the way to great improvements in technique. American designs are not ahead of ours.

"An improvement in circuit design is enabling us to give a much livelier picture than was possible previously. It won't be a bigger picture. It is now possible to get in a small room practically the same impression as in the circle at a first-class cinema. There is no question of flicker now.

"The range will be the same, about 35 miles, but with rediffusion stations it will be possible to get first-class reception practically anywhere in the country."

A member of the trade said: "The price we aim at is approximately £25 plus a further £8 if ordinary radio reception is desired as well."

Army Patent Agencies

ESTABLISHMENT of an Aircraft Signal Patent Agency at Wright Field, Dayton, Ohio, and a Ground Signal Patent Agency at Camp Evans, Belmar, N. J., has been announced by the Office of the Chief Signal Officer.

The Dayton organization will be responsible for preparation of patent applications covering inventions made at the Signal Corps Aircraft Signal Agency laboratories, while the organization at Belmar will have similar responsibility for inventions at the Signal Corps Ground Signal Agency laboratories.

Navy Electronic Training For Volunteers

FORMERLY, only youths of 17 and men in Navy "pools" between 18 and 30 were eligible to take the "Eddy Test," an examination designed to gauge an applicant's fitness for technical training. Now, men in Navy "pools" up to 38 years of age, as well as those 38 to 50 can qualify.

Men who make the grade in this program are sworn into the Navy

FRANKLIN'S *NEW* CATALOG

of electronic components

Illustrated and detailed in this new catalog are the products of 2 years development to meet the rigid requirements of wartime necessity . . . newly designed and patented Sockets, Plugs, Switches, Contacts, Terminal Boards and Assemblies for wartime electronic use.

When the armed services demanded new designs Franklin engineers were ready with a specialized background of many years experience with Radio and Electronic Components and a full understanding of operating conditions under wartime use.

The products shown in this new catalog are war-tested proof of Franklin's ability to develop and produce the goods...today for the armed services . . . tomorrow, the moment Victory is ours, for the Radio and Electronic Industries Peacetime Products.

Design Engineers will find the New Franklin Catalog of inestimable value . . .

Write for your copy on your company letterhead.

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MANUFACTURING CORP.

SOCKETS • TERMINAL STRIPS • PLUGS • SWITCHES • PLASTIC FABRICATION • METAL STAMPINGS • ASSEMBLIES

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are a "Main factor" of the high power electronic tube. Quartz is the best electrical insulator known to science. Many other qualities make it ideal for the job. . . .Not subject to thermal shock. Non hygroscopic. High surface resistance. Shaped to specification.

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Dept. E-8 **NEWARK 5, N. J.**

as seamen, first class, at $66 per month and transferred to service schools in Chicago for 10 month's training in electronics.

After graduation they are rated radio technicians, second class, and then assigned to sea or shore billets to maintain, install and operate various devices. The average graduate is able to qualify for a first class rating shortly after taking up his new duties.

The "Eddy Test" covers basic mathematics, physics, fundamental electricity, shop practice and radio.

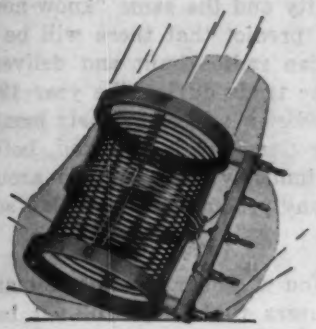
American Programs for Chinese

CHINA'S MOST POWERFUL long-wave station, XGOA in Chungking, is now regularly rebroadcasting short-wave programs by the overseas Branch of OWI originating in San Francisco. Chungking reports that these rebroadcasts of American programs are as clear as local programs originating in Chungking.

Speaking of this evidence of China's technological development, FCC chairman James L. Fly said, "Here is clear evidence of the Chinese Government's desire to stimulate an awareness of global developments among the Chinese people, not just among the most wealthy people with short-wave receiving equipment, but among the middle-class people with less expensive long-wave radio sets. In fact, China has even made a start at bringing foreign radio programs to the lowest income groups, to the man in the street who could not dream of owning a 'receive-listen machine'.

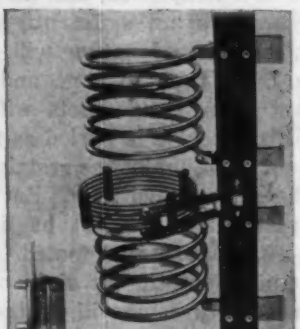
For example, San Francisco is now broadcasting a daily half-hour program especially for Kweilin, one of the great cities of southeast China. This program is rebroadcast by means of a public-address system whose amplifiers are placed at strategic locations throughout the city's streets and parks.

"These developments presage a growing two-way exchange of ideas between the people of America and the people of China—a direct popular intercourse that will lay the foundation for a deep-rooted understanding and friendship in years to come."



Dropped 35 feet to a cement sidewalk, this B & W Air Inductor was immediately put back in perfect operating condition without tools of any kind. Actually, the only damage was a bent "banana" plug, and a cracked support bar.

This indent feature illustrates the versatility of B & W "Air Wound" design. Every turn of the wire is indented on alternating sides of the coil. This means that the windings on both sides of the turn you want to tap are indented out of the way. No matter how small the wire, or how close it is wound, taps can easily be made *anywhere on the inductor.*



"Air Wound" construction is just as desirable for mammoth inductors as it is for small ones. Here you see a B & W No. 1591 Air Inductor, only 2" in diameter by 3" long, in a size comparison with a B & W high-power (10 KW.) coil.

Why WIND COILS ON "AIR"?

"Air Wound" Inductors—pioneered and perfected by B & W—hold many advantages for many applications:

- *They weigh much less. Conventional winding forms are eliminated.*
- *They are readily adaptable to almost any mounting arrangement.*
- *They are far less likely to be damaged if dropped. There is little about them to break—and, even if bent completely out of shape, they can easily be repaired.*
- *They can be protected for rough service with bumper rings —still at a minimum of weight.*
- *They offer greater design adaptability in such valuable features as indented turns which make it easy to tap any turn on a small coil.*
- *They have exceptionally low dielectric loss.*
- *They are wound to uniform pitch.*
- *They lend themselves readily to mechanical and electrical revisions in the circuit.*

. . . For other uses B & W offers a variety of ceramic and phenolic form coils. Whatever your coil problem, come to coil headquarters!

BARKER & WILLIAMSON

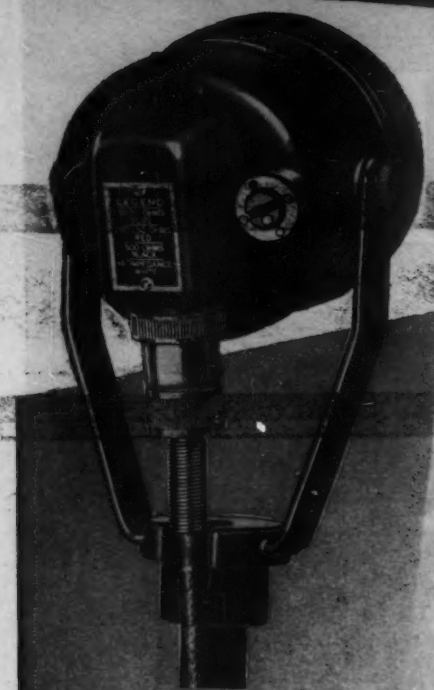
235 FAIRFIELD AVENUE
UPPER DARBY, PA.

Don't Spare the Horses!

when using

TURNER

Microphones



They're Built to "Take It"!

Indoors or out — under any climatic or acoustic condition, the rugged dependability of Turner Microphones is something you can always depend upon. That's why Turners are in such great demand for vital war communications.

GIVE a Turner Microphone the stiffest test you can devise. Use it in any spot, from the finest broadcasting studio to the jungles of the South Pacific, and you'll still be completely satisfied with the beautifully clear, concise and intelligible transmission. "Sound Engineering" combined with rugged construction and stream-lined modern beauty make Turner Microphones first choice of the most critical veterans.

Model U9-S, illustrated, is typical of the dependability and versatility of Turner Microphones. A twist of the switch at the back of U9-S lets you work at your choice of 50 or 200 ohms, 500 ohms or hi-impedance. For full information and prices, write the Turner Co. Now.

Pioneers in the Communications field

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Free

We have a Free Turner Microphone Catalog for you. Write us today.

Revised Standards for Instruments and Shunts

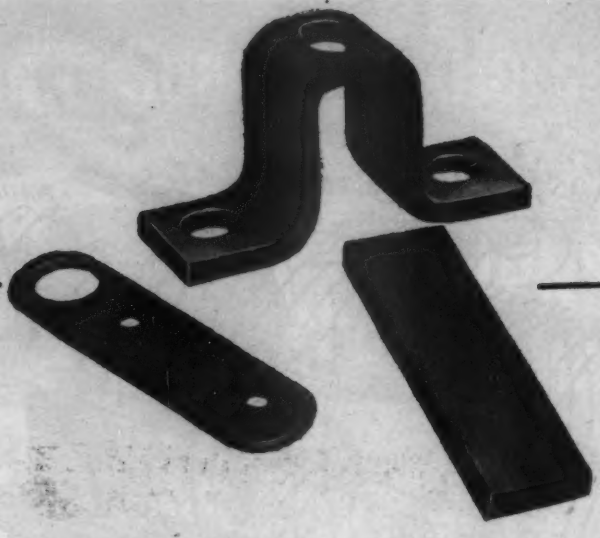
REVISIONS OF American War Standards for electrical panel-type instruments and shunts have been announced by the American Standards Association. These revisions have been made as a result of field experience. They cover performance requirements, test methods, standard dimensions and ranges for a standard series of the instruments mentioned which will meet the quality demanded by the armed forces. The standards provide for complete interchangeability, both electrically and mechanically, but leave the manufacturer free to use his ingenuity in internal design and improvements.

Both standards include applicable specifications and drawings, classification, materials, workmanship, general and detail requirements, methods of sampling, inspection and tests, packaging, packing and marking for shipment, and requirements applicable to individual government departments. Copious notes and drawings further clarify the text.

The American War Standard, Electrical Indicating Instruments (2½-inch, Round, Flush-Mounting, Panel-Type) (C39.2–1944) may be obtained for 50 cents a copy and the standard for External Ammeter Shunts (C39.5–1943) for 25 cents a copy. Both may be ordered from the American Standards Association, 29 West 39th Street, New York 18, N. Y. They are available from the government agency concerned, without charge, for procurement purposes only.

Future Radio Models

PREDICTIONS ABOUT the future of radio were made by Paul V. Galvin, president of the Radio Manufacturers' Association, while addressing the National Retail Furniture Association in Chicago. He reviewed the wide use of radio and special electronic apparatus in the war and pointed out that the radio industry is in a rather unique position in that it is able to make a quick conversion to civilian production. Unlike other industries, the conversion from war radio models to civilian radio models will involve



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SAND BLAST

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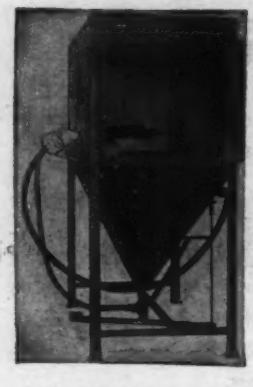
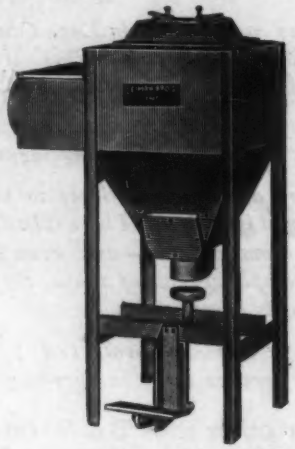


Cabinet Type—work done inside cabinet.

Mass Production Or Small Job Units

Matt Finishing or Frosting for Coloring effect Stencilling Letters or Designs



Cabinet Type—work done by pressing against top aperture on outside.

RAPID CLEANING of Weld Joints

LEIMAN BROS.

155 Christie Street, Newark 5, N. J.

the same type of manufacturing facility and the same "know-how".

"I predict that there will be no civilian radios built and delivered to the trade during the year 1944. I predict it will be over six months after Germany is defeated, before the industry gets squared around for any production of civilian sets.

Authorization

"You will hear from some manufacturers that they will get back into civilian production in ninety to one hundred and twenty days. Unfortunately, that statement is inferentially interpreted as ninety to one hundred and twenty days after Germany is licked. In reality, it will be some time after the Limitation Order under which we are now operating is altered by WPB, and we get authorization to use materials for civilian radio sets.

I don't think the operational services of the Army, Navy and Air Corps will leave the radio industry off the hook the day after Germany is defeated. They will appraise their further needs from our industry for the Pacific job. After this appraisal, we will get some relaxation of the Limitation Order from WPB, and there will be an allocation of "X" amount of material in order to make "X" quantity of radio sets by "X" number of radio manufacturers. From this release, there will not be enough radios to fill the market needs from the start.

As the Pacific phase of the war draws to a completion, and the military services are sufficiently supplied, greater relaxation will continue from time to time and increased quantities of sets will be made from period to period as time goes on, until finally the restriction will be removed entirely. But the full restriction will not be lifted until after Japan is defeated.

"Upon resumption of civilian radio manufacture, we will get broadcast receivers, both the AM and FM type. There will be no Victory models. Each manufacturer will have his own designs. We may possibly get phonograph combinations on the first release. Phonograph combinations will depend upon how soon we will resume production and upon the material situation at that time. Retail prices of radio sets on resumption of civilian

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Whether you buy, use or design mechanical springs, this new engineering handbook will prove interesting and practical. Its purpose is to collect and present charts, tables and formulas upon which the engineering and design of mechanical springs are currently based. The material offered represents the research and knowledge of the combined engineering forces of the several Divisions of the Associated Spring Corporation. Helpful pointers on the selection of materials, types of springs, methods of calculation — all appear in easy-to-read, simple language.

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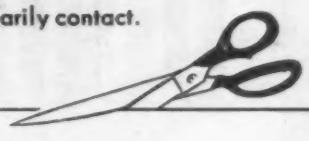

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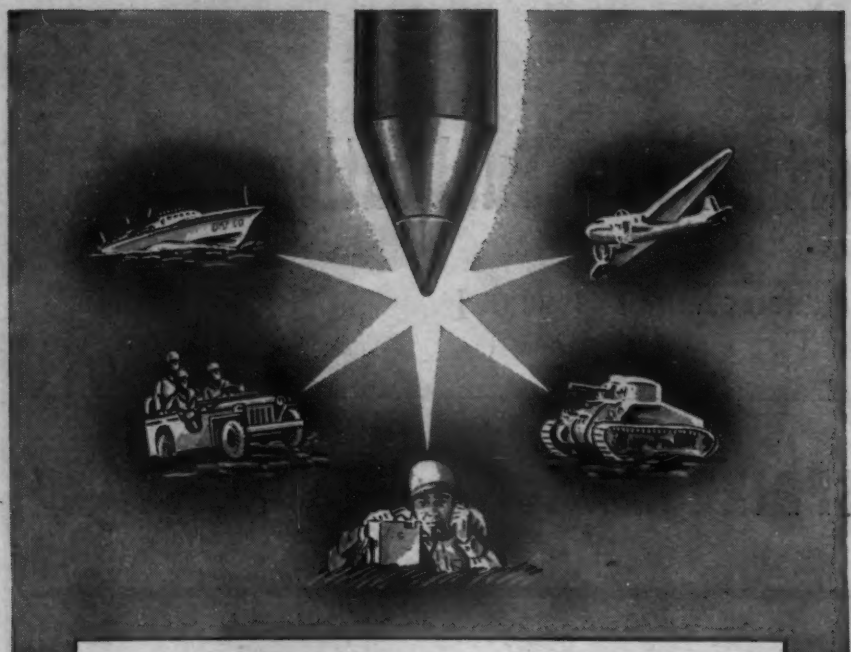

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WRITE FOR FULL PARTICULARS TODAY

production will be from 25 to 40 percent higher than pre-war sets.

Television

"I believe that there will be no television sets built until after Japan is defeated. Technically, television is here today, but the system standards and frequency allocation problems, as well as the station transmitting problems, relay station problems, and programing problems for commercial television will hold it back. However, when commercial television does come it will move very fast. Technical advances during the war have brought forth improvements that make possible moderately priced television sets which will reach the mass market.

Television after the war will not be confined to a little peep-hole view somewhere in front or on top of the television cabinet. Projection of a good-sized picture on the wall will make it much more acceptable from a viewing standpoint. The post-war opportunities in manufacturing, merchandising, advertising, programing, and broadcasting of television open such a tremendously interesting field for American ingenuity and enterprise that we will have a new industry—television—superimposed onto a now already large industry—the radio industry.

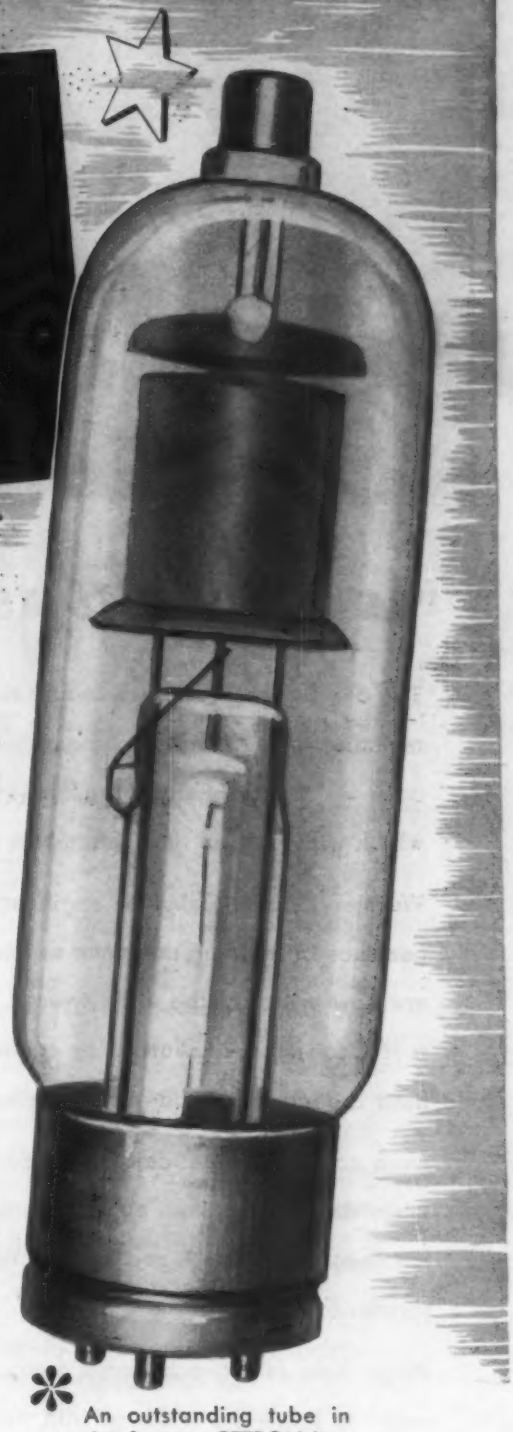
Combinations

"After the war, the automatic radio-phonograph combination is going to be the source of tremendous business. I don't thing the wax platter record is going to pass out, the record manufacturers are not sound asleep. The automatic radio-phonograph combination will be within reach of the mass American buying public, and it will be an instrument of very high quality.

Radio discounts, in my estimation, were not out of line before the war considering the service and trade-in problems, and I believe about the same discount structure will prevail upon resumption of sales.

This is a thumb-nail picture of post-war radio as I see it. The term "post-war" is somewhat ambiguous because we are not actually going to wait until our entire war effort is completed before we resume the production of civilian

CETRON
RECTIFIER
CE 872-A *



- Continental, one of the pioneers in the electronic tube industry, produces a wide range of Power Rectifiers, grid control tubes (Thyratrons), Phototubes and other special electronic tubes.
- Long before the war, their high quality and thorough dependability had earned for them national recognition and acceptance by many of the country's leading companies. From raw materials to the finished tube, we tolerate only the best of materials, rigidly controlled processes, close inspections and exacting final tests.
- Have you a tube problem? If so, perhaps we can help you as we have helped many others. Your inquiry is invited—No obligation incurred.

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We produce a wide line of
RECTIFIERS, PHOTOTUBES AND ELECTRONIC TUBES

Write for catalog giving complete details.

* An outstanding tube in the famous CETRON line

- Continental's CE 872A is designed to meet rigid Army and Navy specifications. It incorporates numerous improvements in design and processes which insure EFFICIENCY . . . RUGGEDNESS . . . LONG LIFE.
- Detailed specifications are given in Bulletin 117-A which will be sent on request. We are able to make prompt delivery on satisfactorily rated orders.

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"AS *Modern* AS TOMORROW"

The old phrase—"as modern as tomorrow"—has taken on new meaning in these times. Research and development have become a feverish activity in the laboratories of American industry, which will result in new peace-time products.

Webster Electric's skill in engineering and long years of experience in building magnetic reproducers and crystal pickups are now a part of the effort toward winning the war. And the search for improvements, to meet the constant demand for even finer products, goes on in these laboratories, too.

Even now homes that enjoy radio-phonograph combination sets know the pleasure and entertainment that brings relaxation in the midst of crowded, hectic days. Webster Electric Pickups are standard on many of these sets.

When new sets can be built again, Webster Electric will be ready to serve the industry with new developments designed for the modern world of tomorrow.

(Licensed under patents of the Brush Development Company)

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WEBSTER ELECTRIC

"Where Quality is a Responsibility and Fair Dealing an Obligation"

LET'S ALL BACK THE ATTACK—BUY MORE WAR BONDS!

sets. We are going to resume production some time after the European phase has been concluded. This period will cover the filling of the pipe lines with very greatly improved models. From there on out, the industry will continue to incorporate its war-time improvements into models which will meet the current radio wants of consumers."

Dry Cells for Civilians

ALTHOUGH THE MATERIALS situation has improved, and facilities of the industry have been greatly expanded, the possibility of increasing the supply of dry batteries for civilian use in 1944 appears remote. In fact, production of some kinds of batteries used by civilians may be even lower than in 1943, according to the Consumers Durable Goods Division of WPB.

Last year the dry battery industry produced the equivalent of 3,750,000 radio battery packs, compared with 3,500,000 produced in 1940. Less than two percent of this quantity was used in industrial and technical equipment. All the rest went to the farm market.

Shipments of No. 6 type batteries, including multiple types, were almost exactly the same in 1943 as in 1940. These batteries are used to a large extent in rural areas for telephones, gas engine ignition, and electric fences. Large quantities are used also by railroad, telephone and telegraph companies, by the fishing industry, and for protective alarm systems.

More than 55,000,000 individual cells were produced for assembly into hearing aid batteries. Final figures show that production of assembled hearing aid B batteries reached a total of approximately 1,600,000.

Lantern battery shipments were 85 percent higher than in 1940. Almost the entire amount produced went to railroads for use by trainmen.

Approximately half as many flashlight batteries were shipped in 1943 as in 1940, and many of these did not reach the retail market. War plants, public utilities, and other users, whose requirements had increased as a result of the war, received a much greater share than in 1940.

All military operations, on land

Smart Electronic Equipment Builders

WIRE-PLAN PRODUCTS IN THE DESIGN STAGES

TO PREVENT WIRE-FAILURES LATER

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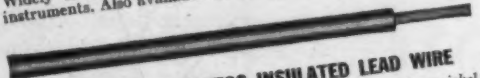
PERMANENTLY INSULATED

WIRES, CABLES AND CORDS

ROCKBESTOS FIREWALL HOOKUP CORD

Sizes No. 22 to 4 AWG in 1000 volt rating, and No. 12, 14 and 16 AWG in 3000 volt. Individual conductors insulated with synthetic tape, impregnated felted asbestos, and covered with glass, cotton or rayon braids.

This flame-resistant high dielectric hookup cord, made up of single conductor Rockbestos Firewall Hookup Wires, is obtainable in either two or three conductors with plain or color-coded braids. Operating temperature range 125°C. to minus 50°C. Widely used in aircraft radio and ground installations, and instruments. Also available with tinned copper shielding braid.



ROCKBESTOS ASBESTOS INSULATED LEAD WIRE

Sizes No. 22 to 4 AWG solid or stranded copper, monel or nickel conductors insulated with .031" or .040" of impregnated felted asbestos in black, white or colors.

Heatproof and flame-resistant, this lead wire will not bake brittle and crack under vibration, won't rot, swell or flow when in contact with oil or grease, and has ample moisture resistance for most applications.

ROCKBESTOS ASBESTOS INSULATED MAGNET WIRE

Round, square and rectangular asbestos insulated conductors finished to meet varying winding conditions and coil treatment requirements.

Designed for Class B windings and also suitable for use as insulated bus wire where high dielectric strength is not required. The insulation is non-checking and is unaffected by heat or aging.

ROCKBESTOS MULTI-CONDUCTOR FIREWALL INSTRUMENT CABLE

This small diameter, light weight, high dielectric control cable containing three No. 26 AWG Rockbestos Firewall Wires, originally designed to provide a compact space-saving construction for an electronic device, is made to a nominal diameter of .125" (smaller than No. 14 AWG single conductor 1000 volt Rockbestos Firewall Radio Hookup Wire).

A few of the 122 wires, cables and cords developed by Rockbestos to meet unusual operating conditions.

Don't get left at the post by neglecting important little things in post-war designing . . . do your wire-planning while the projects are on the drafting board and avoid trouble later. Give necessary consideration to dielectric strength, operating temperatures, voltage ratings, wire "specs," conditions under which your product may be used, diameters of glands, bushings, knockouts, bend radii of wireways, etc., . . . and eliminate wire-failures in advance.

Investigate *permanently insulated* Rockbestos wires, cables and cords for trouble-free performance. These wires all have built-in characteristics that provide resistance to heat, cold, flame, moisture, oil, grease and corrosive fumes. If one of our 122 standard constructions won't do, Rockbestos Research will be glad to cooperate with you in developing a wire that will exactly meet your specific performance specifications. For engineering assistance or information write our nearest branch office or:

Rockbestos Products Corporation, 410 Nicoll St., New Haven 4, Conn.

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★ *FOR VICTORY—INVEST IN WAR BONDS* ★

you can't teach an old dog new tricks

That's a proverb that is all wrong. We are doing new things with mica every day. Shaping and forming to precision standards. Whatever can be done with Mica we can do . . . new tricks too.

When you think of MICA think of MACALLEN

the Macallen Company

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CHICAGO: 903 W. Washington Blvd. CLEVELAND: 1005 Leader Bldg.

and sea and in the air, require enormous quantities of dry batteries. If batteries are not immediately available, it is because batteries are needed for walkie-talkies, bazookas, signal lights, or other war equipment.

RMA Standardization Setup

THERE HAS RECENTLY been some misunderstanding of the functioning of the standardization machinery of the RMA Engineering Department and the following expanation of the origin and theory of operation is timely, as plans are being formulated now for the post-war operation of the Engineering Department and constructive comments would be welcomed by Virgil M. Graham, associate director of the Department. His address changed recently and communications should be addressed to him at Radio Manufacturers Association, P. O. Box 750, Williamsport, Pa.

Reorganization for peacetime activities may require minor changes in the details of operations.

In the early days of the RMA engineering activities, standards or recommended practices were proposed by any of the several engineering committees, considered by a "General Standards Committee" and, if approved, submitted to the membership by "letter ballot". If 90 percent of the votes were favorable (ballots not returned were considered affirmative) the proposal became an RMA Standard or Recommended Practice. The obvious difficulty with this system was that there usually were so few ballots returned that the proposal had to be considered approved "by default". This procedure was bad because when valid objections were raised with one or two negative ballots, they had to be disregarded according to the rules unless the chairman of the Standards Committee exercised a power not delegated to him and threw the subject back to the committees.

SAE System

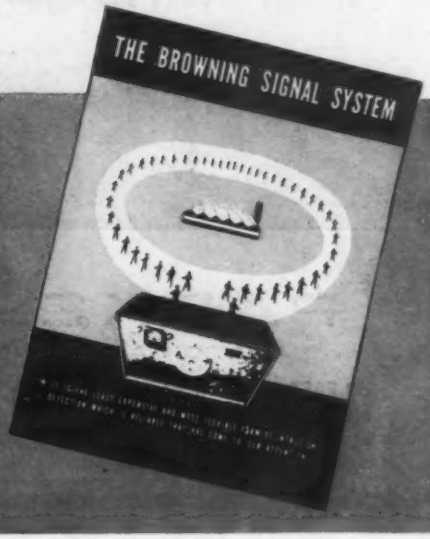
About 1934, a survey was made of the standardization procedure of several similar organizations. This survey indicated that the procedure evolved and used with satisfaction by the Society of Automotive Engineers suited our needs

THIS GUARD'S BACK IS *Never* TURNED

The Browning Signal System for plant protection effectively covers every inch of a given "beat" by means of a balanced-capacitance, electronic circuit. Proved in service before Pearl Harbor, it obviates human failure, releases guards for needed man-power.

Browning Frequency Meters pre-check radio transmitters, help assure communications clarity and dependability. Long have been standard equipment for police, fire, public utility and similar emergency radio systems. Meet FCC requirements.

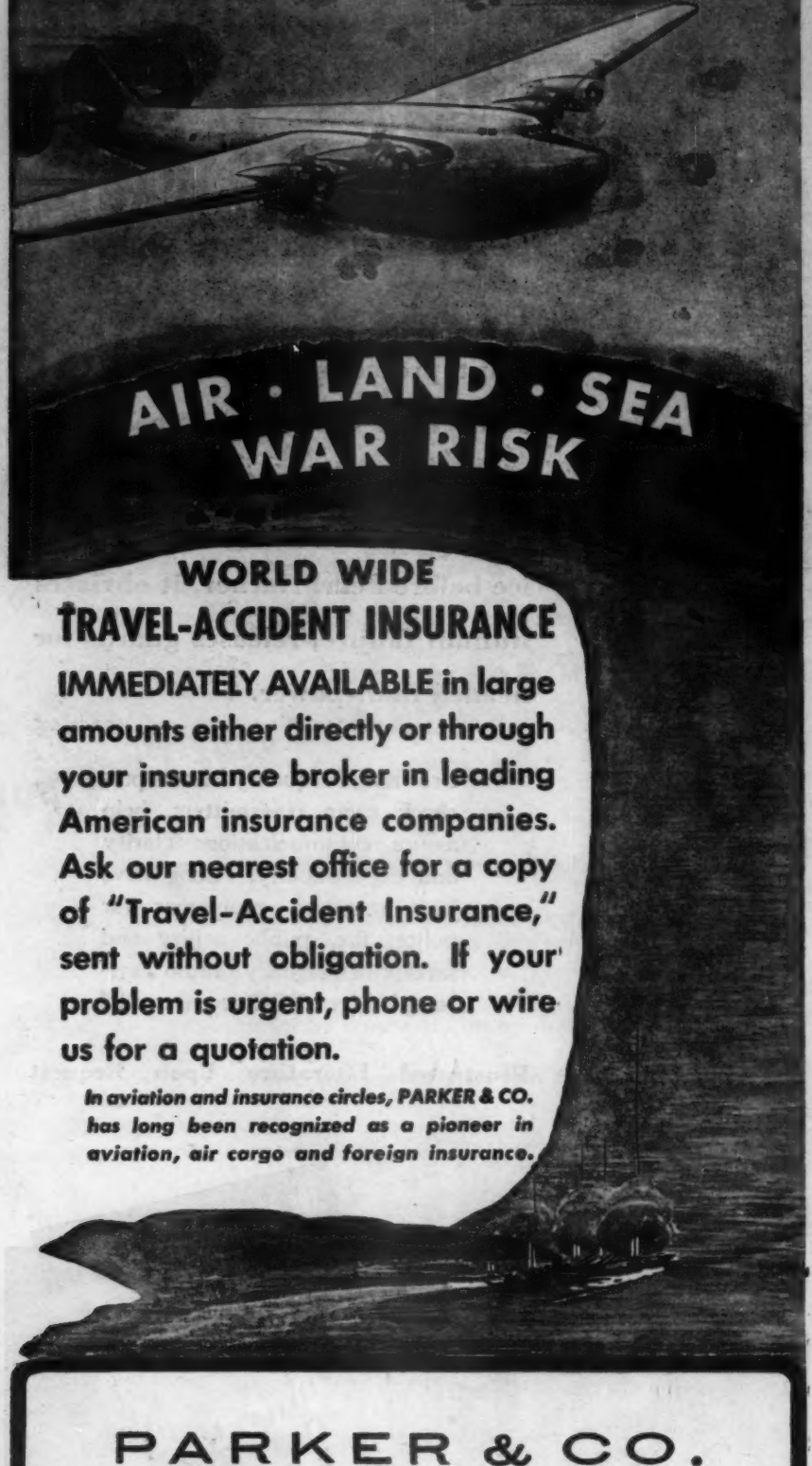
Illustrated Literature Upon Request



BROWNING

LABORATORIES, INCORPORATED

WINCHESTER, MASSACHUSETTS


AIR · LAND · SEA
WAR RISK
WORLD WIDE
TRAVEL-ACCIDENT INSURANCE
IMMEDIATELY AVAILABLE in large amounts either directly or through your insurance broker in leading American insurance companies. Ask our nearest office for a copy of "Travel-Accident Insurance," sent without obligation. If your problem is urgent, phone or wire us for a quotation.
In aviation and insurance circles, PARKER & CO. has long been recognized as a pioneer in aviation, air cargo and foreign insurance.
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quite well. This system eliminated the bad features of the one outlined above and provided needed flexibility for our industry.

This SAE System, as adapted to RMA provides for the formulation and proposal of material for standardization by the several committees or sections of the Engineering Department, on their own initiative or on request of the various RMA Divisions on occasion. The material is then circulated in the form of "Standards Proposals" requesting comment and criticism. These Standards Proposals are sent to all members of all engineering committees, the executive of each member company, and now to the members of all divisions and sections of RMA. When comment and criticism is received it is filed with the particular Standards Proposal and prior to the ensuing meeting of the General Standards Committee these files are incorporated into an agenda for this meeting.

Recommendations

This General Standards Committee has no power to make changes in a proposal other than minor ones of an obvious or editorial nature as result of comments received. Its actions are therefore confined almost entirely to acceptance, rejection, or reference back to the formulating committee with recommendations. These actions must be based on the answers to the Standards Proposals or discussions in the meeting, where new objections are sometimes raised as a result of occurrences subsequent to the Standards Proposal procedure. In other words the General Standards Committee functions as a quasi-judicial group deciding on the validity of any objections to the material proposed for standardization. It is obvious that this type of procedure eliminates the major objection to the older procedure, as now one valid objection can at least cause the proposal to be reconsidered, whereas if the industry has raised no objections and if the members see none, the proposal becomes an RMA Standard or RMA Recommended Practice. The General Standards Committee can act only *in meeting*.

Typical Procedure

If several unfavorable comments

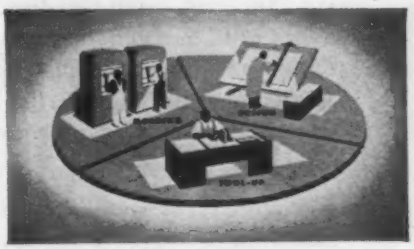
Make Sure of ENGINEERING when you choose your Plastic Molder

Engineering is only one of the functions a Plastic Molder must perform . . . but it's a vital one. And we'll whistle *that* again!

Because without a thorough knowledge of toolmaking, molding compounds and molding techniques, ideas never become blueprints, and blueprints never become products. That's why we forever feature engineering functions at Kurz-Kasch.

From the blueprint to the finished parts, of course, more specialized skills are called for. Here at Kurz-Kasch, they all find a common meeting place with your engineers at the Plastics Round Table . . . where a generation of experience in plastics is pooled to work out the best Engineering and Production treatment of your application.

Behind all this lies the production capacity of a large and modernly equipped plant which we confidently expect to keep quite busy after the war. We know, because right now we're talking Engineering on many products for customers both old and new. If you're interested in Plastics —now's the time! No obligation.



THE EARLIER Engineering gets on the job, the better! When you look at a top-notch plastic application, it's ten to one that the Custom Molder sat in on the job from the ground floor up. Let us help with blueprints *and* molding material specifications.

WAR BONDS BUY VICTORY—HAVE YOU BOUGHT YOURS TODAY?

KURZ-KASCH

For over 25 years Planners and Molders in Plastics

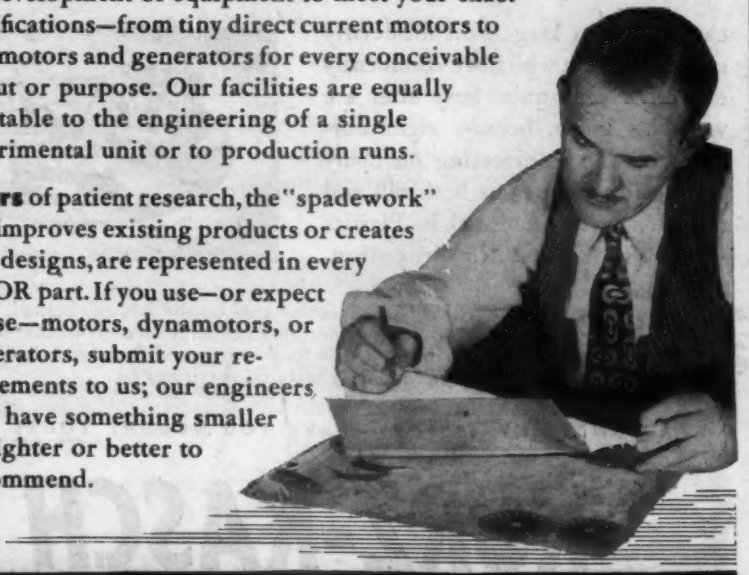
Kurz-Kasch, Inc., 1421 South Broadway, Dayton 1, Ohio

Branch Sales Offices: New York • Chicago • Detroit • Indianapolis • Los Angeles • Dallas St. Louis • Toronto, Canada. Export Offices: 89 Broad Street, New York City

Far in advance of today's production schedules and in anticipation of tomorrow's needs, EICOR engineers are preparing to meet the inevitable demand for rotary electrical equipment designed for new applications. During recent years their store of knowledge has been used to direct our activities and those of others in the manufacture of more and better motors and dynamotors for war service. The breadth of experience gained in this effort fits them, and our entire organization, for an important future in this field.

An exceptional range of designs and frame sizes facilitates the development of equipment to meet your exact specifications—from tiny direct current motors to dynamotors and generators for every conceivable output or purpose. Our facilities are equally adaptable to the engineering of a single experimental unit or to production runs.

Years of patient research, the "spadework" that improves existing products or creates new designs, are represented in every EICOR part. If you use—or expect to use—motors, dynamotors, or generators, submit your requirements to us; our engineers may have something smaller or lighter or better to recommend.



EICOR INC. 1501 W. Congress St., Chicago, U.S.A.
DYNAMOTORS • D. C. MOTORS • POWER PLANTS • CONVERTERS
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are received on a Standards Proposal they are forwarded to the formulating committee to give it a chance to revise the Proposal to reconcile it with valid criticism before it goes to the General Standards Committee. After such revision the material is again sent out in Standards Proposal form. A limited amount of flexibility of action in this respect is allowed as many times as a formulating committee may fix up objectionable points in a proposal just prior to the meeting of the General Standards Committee. In such a case, the Chairman of the particular committee presents the revision to the General Standards Committee and it decides whether to accept the revised proposal or whether it should again go out as a Standards Proposal.

Both RMA Standards and RMA Recommended Practices should have the same use, validity, and importance to be adopted. In general, standards are made for concrete matters such as shaft dimensions, etc. Recommended Practices are formulated for actions or procedures such as furnishing instruction sheets, etc. Thus a Recommended Practice on furnishing instruction sheets might lead to a Standard on the form of the sheet.

Provisional Standards

While the above standardization procedure has not been functioning during the war period for obvious reasons, any "standards" which may be printed during that time through actions of the several wartime committees are only "Provisional Standards" and will not be adopted as RMA Standards (or Recommended Practices) until after the reconstitution of the General Standards Committee at such time as our industry is reconverted to peace time activity. No material will bear the term "RMA Standard" unless it has passed through all the processes prescribed by the "Organization and Working Rules" of the RMA Engineering Department.

A NEW PATENT suggests flooding movie theaters with ultraviolet radiation at low intensity. Fluorescent material on the seats and carpeting would help patrons find seats.

Crystals FOR THE CRITICAL

The JAMES KNIGHTS Co.
SANDWICH, ILLINOIS

JK CRYSTALS

Center Scope Brings Optical Precision to Machine Shop Operations

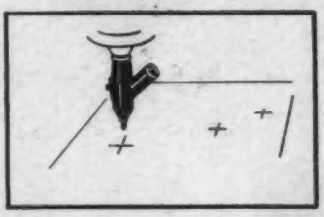
The Center Scope is an optical centering and locating tool that can be easily and quickly used on any machine to center work reference lines to a spindle axis. It permits accuracy to a degree never before obtainable, as the optical beam or line of sight is absolutely inflexible and cannot be distorted.

The Center Scope's easy accuracy eliminates many human errors, as the operator can see just what the cutting tool will do before it is actually fed into the work. It increases production, improves efficiency and prevents spoilage. There is no pressure on the work piece nor is it subject to wear or changes in temperature—for the Center Scope never touches the layout.

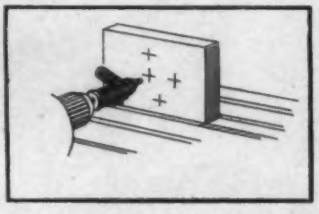
The Center Scope enables the operator to easily and quickly locate edges to a spindle axis, set-up faster and compensate for run-out. It saves vital hours in checking, inspecting and measuring when mechanical methods and tools are impossible to use. Its 45 x magnification allows operator to see ".001" and requires no technical knowledge or training to operate.

While there is nothing particularly new or ingenious about Wrigley's Spearmint gum, it is proving useful to millions of people in many new ways. Workers in war plants everywhere have found it helps keep them alert and relieves nervous tension and dry mouth while they are on the job.

You can get complete information from the Center Scope Instrument Company, 351 S. LaBrea Ave., Los Angeles, California, or Kearney & Trecker Products Corporation, Milwaukee, Wisconsin.



ON A VERTICAL MILL—locating and centering height gauge or size block layouts. Permits jig borer accuracy on more machines.



ON A HORIZONTAL MILL—the ability to center a layout, edge block or rotary table plug while spindle is running. Permits quick and easy set-up for high precision work.

Y-111

BWC on International Communications

THE BOARD OF War Communications has ordered that

(1) Non-governmental business radiotelephone calls between the United States and Great Britain shall be permitted subject to the prior approval thereof from the Office of Censorship. No personal radiotelephone calls shall be permitted between the United States and Great Britain.

(2) No non-governmental business or personal radiotelephone call shall be made to or from any foreign point outside of the Western Hemisphere other than Great Britain unless such call is made in the interest of the United States or the United Nations and unless an agency of the United States Government sponsors such call and obtains prior approval therefor from the Office of Censorship. This provision shall not apply to American press calls or radio broadcast programs, or to such other press calls and radio programs as may be specifically approved by the Office of Censorship.

(3) No calls of any nature, over the radiotelephone circuits under the jurisdiction of the United States, no matter where such calls may originate, unless sponsored and approved as provided in paragraph (2), shall be permitted to, from, or on behalf of, the following thirteen countries: Egypt, Finland, France, Iceland, Iran, Ireland, Latvias, Lithuania, Portugal, Spain, Sweden, Switzerland, and Turkey.

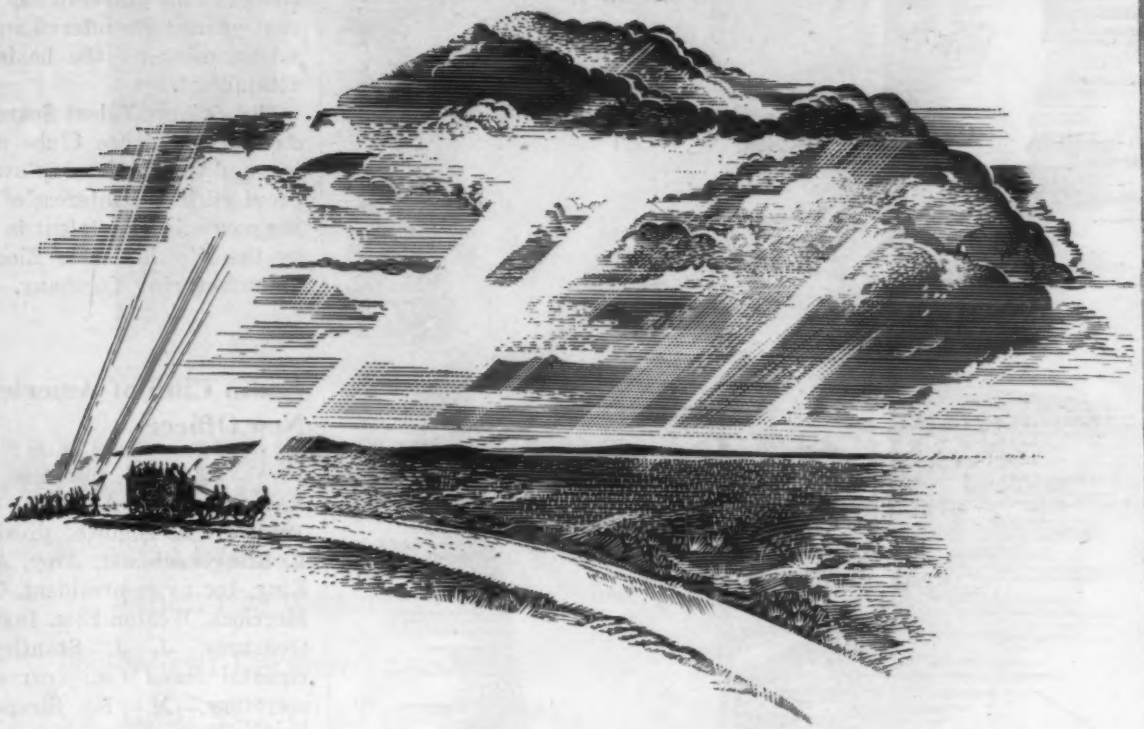
Science Talent Search Finalists

FORTY FINALISTS in the third annual nationwide Science Talent Search attended a five-day, all-expense Science Talent Institute in Washington during March when they met leaders in many fields of science and high government officials.

During the Institute, interviews and final examinations determine the award of two four-year Westinghouse Science Grand Scholarships worth $2,400 each, and at the discretion of the judges, up to $3,000 in additional scholarships.

Citations of honorable mentions

HERE'S THAT BANDWAGON AGAIN



Once in a blue moon it comes along . . . that symbol of great opportunity dear to the heart of every progressive American—the Bandwagon! It's here again!

This time the Bandwagon is Television. You've been waiting for it. Do you recognize it now that it's time for the first seats to be taken? Better look again.

Television stands today where radio stood a few years ago . . . where movies stood a few years earlier. Those Americans who were *the first to climb* aboard are continually congratulating themselves!

Men who can judge the future by the past are already climbing aboard this 1944 Bandwagon. They know that television, which combines the best in radio and movies (plus a few things of its own), promises to confound the skeptical and reward the enterprising by soaring to the greatest heights of all . . . *soon*.

Plan *now* for your telecasting studio. Reserve that equipment *now*... equipment that insures low cost operation. These things can be done. DuMont will do them for you.

Allen B. DuMont has specialized in television since it was a laboratory curiosity. By developing the DuMont Cathode Ray Tube, he earned the title, "The Man Who Made Commercial Television Practical"; he put wheels on Television's Bandwagon. Climb aboard!

The man who made commercial television practical can make it profitable for you.

Allen B. DuMont, creator of the DuMont Cathode Ray Tube. DuMont is now providing complete plans for complete telecasting equipment . . . will custom-build your transmitting set-up, provide training for personnel at cost, equip your station, reserve your material. The very cornerstone of this service is low cost of operation. We invite your inquiries.

DUMONT *Precision Electronics and Television*

ALLEN B. DuMONT LABORATORIES, INC., GENERAL OFFICES AND PLANT, 2 MAIN AVENUE, PASSAIC, N. J.
TELEVISION STUDIOS AND STATION W2XWV, 515 MADISON AVENUE, NEW YORK 22, N. Y.

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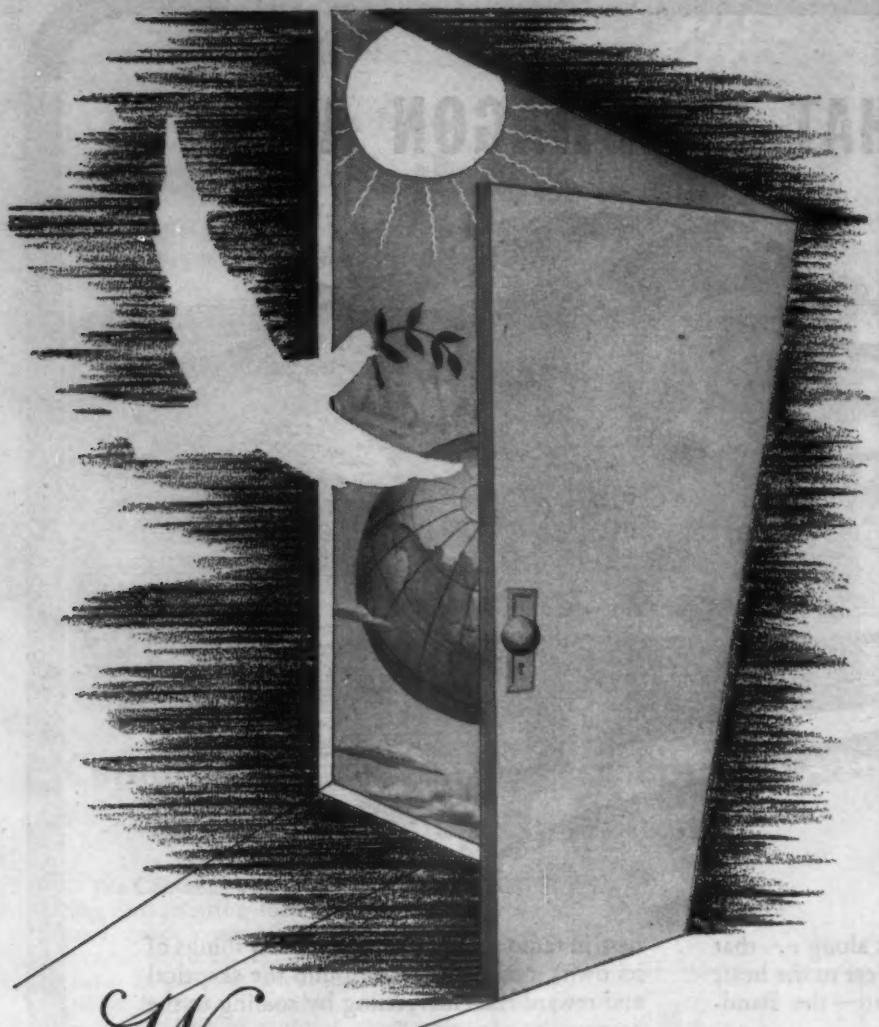


Will you be ready when **PEACE** *unlocks the door ?*

● There's a bright tomorrow on the way. A tomorrow of Peace . . . and progress. And today is the time to prepare to meet its challenge!

● For with Peace will come the call for new developments, new devices for man's betterment. Many are now in the making . . . many more will come. An integral part of many post-war improvements will be crystals,—perfect crystals such as we now turn out in huge quantities for the armed forces.

● Your plans may include equipment in which crystals may be used. Perhaps other developments of our engineers may be just the thing you're looking for. Call on us. We'll be glad to work with you on any problem.

Scientific Radio Products Company

ARMY E NAVY

7.38 W. BROADWAY, COUNCIL BLUFFS, IA

LEO MEYERSON W9GFQ
E. M. SHIDELER W9IFI

MANUFACTURERS OF PIEZO ELECTRIC CRYSTALS AND ASSOCIATED EQUIPMENT

were also awarded to 260 entrants who ranked high in the preliminary phases of the Search, but not high enough to qualify as delegates to the Institute. Honorable mentions are brought to the attention of all colleges and universities, which in past years have offered substantial scholarships on the basis of this attainment.

The Science Talent Search is conducted by Science Clubs of America, and the scholarship awards are provided in the interest of developing new scientific talent in America by the Westinghouse Electric and Manufacturing Company.

Radio Club of America New Officers

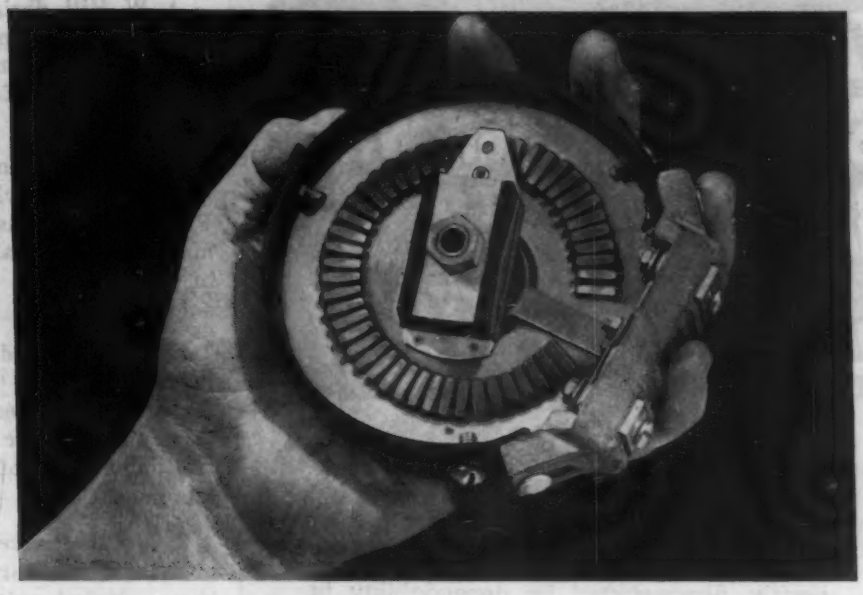
NEWLY-ELECTED OFFICERS of the Radio Club of America, Inc., for 1944, are as follows: president, F. L. Klingenschmitt, Amy, Aceves & King, Inc.; vice-president, O. James Morelock, Weston Elec. Inst. Corp.; treasurer, J. J. Stantley, Continental Sales Co.; corresponding secretary, M. B. Sleeper, *FM Radio-Electronics;* and recording secretary, J. H. Bose, engineer connected with Major E. H. Armstrong at Columbia University.

Personnel

Dr. Vannevar Bush, director of the office of Scientific Research Development of the Office of Emergency Management and president of the Carnegie Institution of Washington, received the 1943 Edison Medal of AIEE at the winter meeting in January. He is chairman of the joint committee on new weapons and equipment of the joint United States Chiefs of Staff since 1942, and is a member and former chairman of the National Advisory Committee for Aeronautics.

W. R. David, G-E engineer since 1919, has been named sales manager of broadcast equipment for the Transmitter Division of the General Electric Co. Electronics Department.

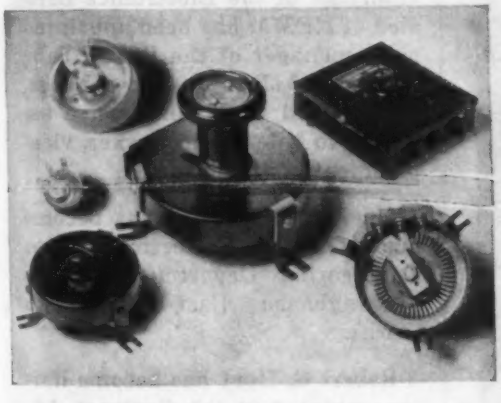
Les Willyard has been appointed chief engineer of Universal Microphone Co.



A SMALL RHEOSTAT with *BIG* FEATURES

The fact that a Rheostat is small, in no way diminishes the importance of its functioning.

Ward Leonard recognizes this and has produced their 4" Plate Type Rheostat with all the desirable features of their largest equipment. It dissipates heat from both sides. The contacts are solid metal blocks for durability. Action is smoothness itself. There are forty-three steps of control.



WL RHEOSTAT BULLETINS

Bulletins are available describing the various Ward Leonard Rheostats. The line is complete including from the small ring types up to the heaviest duty, multiple mounted, power driven units. Write for data bulletins describing the type of Rheostats of interest to you.

ARMY E NAVY

ARMY E NAVY

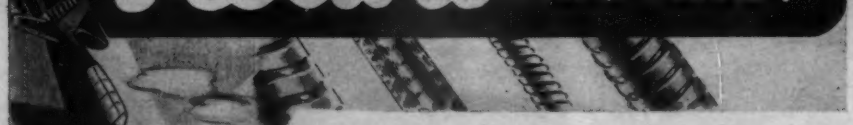
WARD LEONARD

RELAYS • RESISTORS • RHEOSTATS

Electric control WL *devices since 1892.*

WARD LEONARD ELECTRIC COMPANY, 32 SOUTH STREET, MOUNT VERNON, NEW YORK

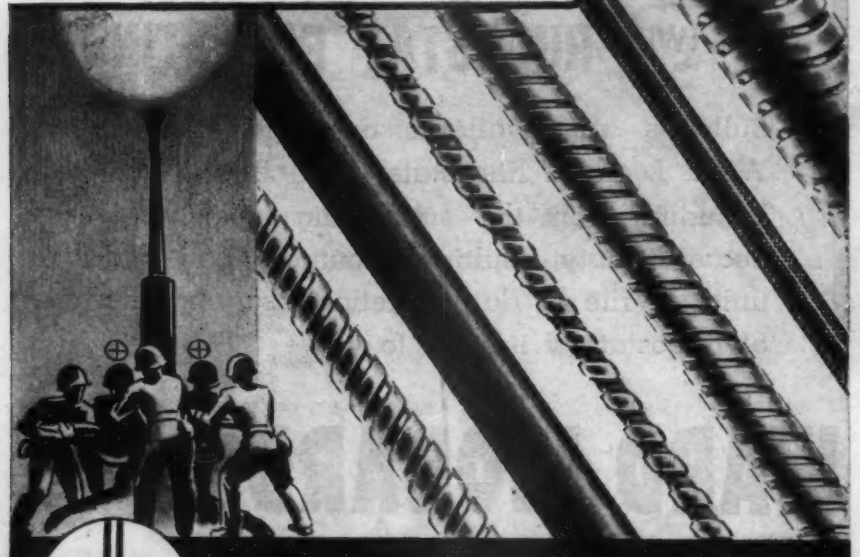
WAR'S TESTS POINT THE WAY FOR POST-WAR REDESIGN WITH WALKER-TURNER Flexible SHAFTING!



Walker-Turner Flexible Shafting has thoroughly demonstrated its dependability in aircraft and other mechanical weapons—where requirements are especially severe. When the war emergency arose, this shafting was ready, having been used for many years in Walker-Turner Flexible Shaft Machines and in industrial machinery produced by other manufacturers. Today, in the redesign of mechanical products for post-war use, engineers are turning more and more to Walker-Turner Flexible Shafting as a solution to problems in light power transmission and remote control. Can we help you?

WALKER-TURNER COMPANY, INC.

Plainfield, N. J.



walker-turner COMPANY, INC. PLAINFIELD, N.J. U.S.A.

FLEXIBLE SHAFTING

FOR REMOTE CONTROL AND POWER TRANSMISSION

A. W. Hill, design engineer, has been named manager of Power Circuit Breaker Engineering at the Westinghouse East Pittsburgh Works.

George C. Connor, radio field engineer with Sylvania Electric Products, Inc., has been appointed manager of the California division of the company's equipment tube sales.

Lloyd Long, radio engineer and instructor at the Oakland Airport for United Airlines, is now technical engineer in the production control laboratory of Universal Microphone Co.

R. Morris Pierce, chief engineer of WGAR for thirteen years, has been elected vice-president in charge of engineering of WJR, Detroit, WGAR, Cleveland, and KMPC, Los Angeles. He is chief engineer of Psychological Warfare for OWI and made possible the broadcast of surrender terms to the Italian navy. Lloyd Wingard will serve as acting chief engineer of WGAR until Pierce returns from overseas and a successor is named.

Charles Hubbard Hill, for forty years design engineer with General Electric Co., died at his home in Drexel Hill, Pa. at the age of seventy-four.

Henry J. Hoffman, engineer and chairman of the Electronics Division of NEMA, has been appointed sales manager of the Power Tube Division of Machlett Laboratories, Inc. as well as administrative assistant to Miles Pennybacker, vice-president of the company.

Herbert L. Rawlins has become manager of the Protective Devices Engineering Department at the Westinghouse East Pittsburgh Works.

Robert G. Hoof has become liaison engineer in the Contract Administration Department of Pacific Division of Bendix Aviation Corp.

Harry K. Werst, partner and former staff engineer of Booz, Allen and Hamilton, has been appointed vice-president in charge of manufacturing of Elastic Stop Nut Corp.

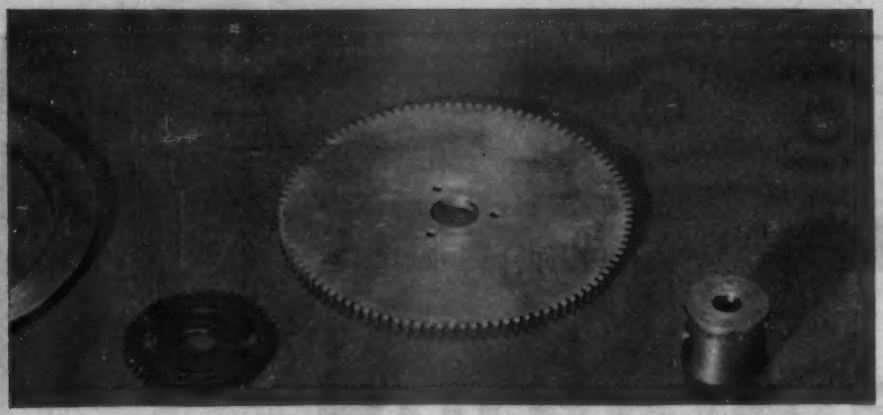
Connecticut Telephone and Electric Division,

MERIDEN — GREAT AMERICAN INDUSTRIES INC. — CONNECTICUT

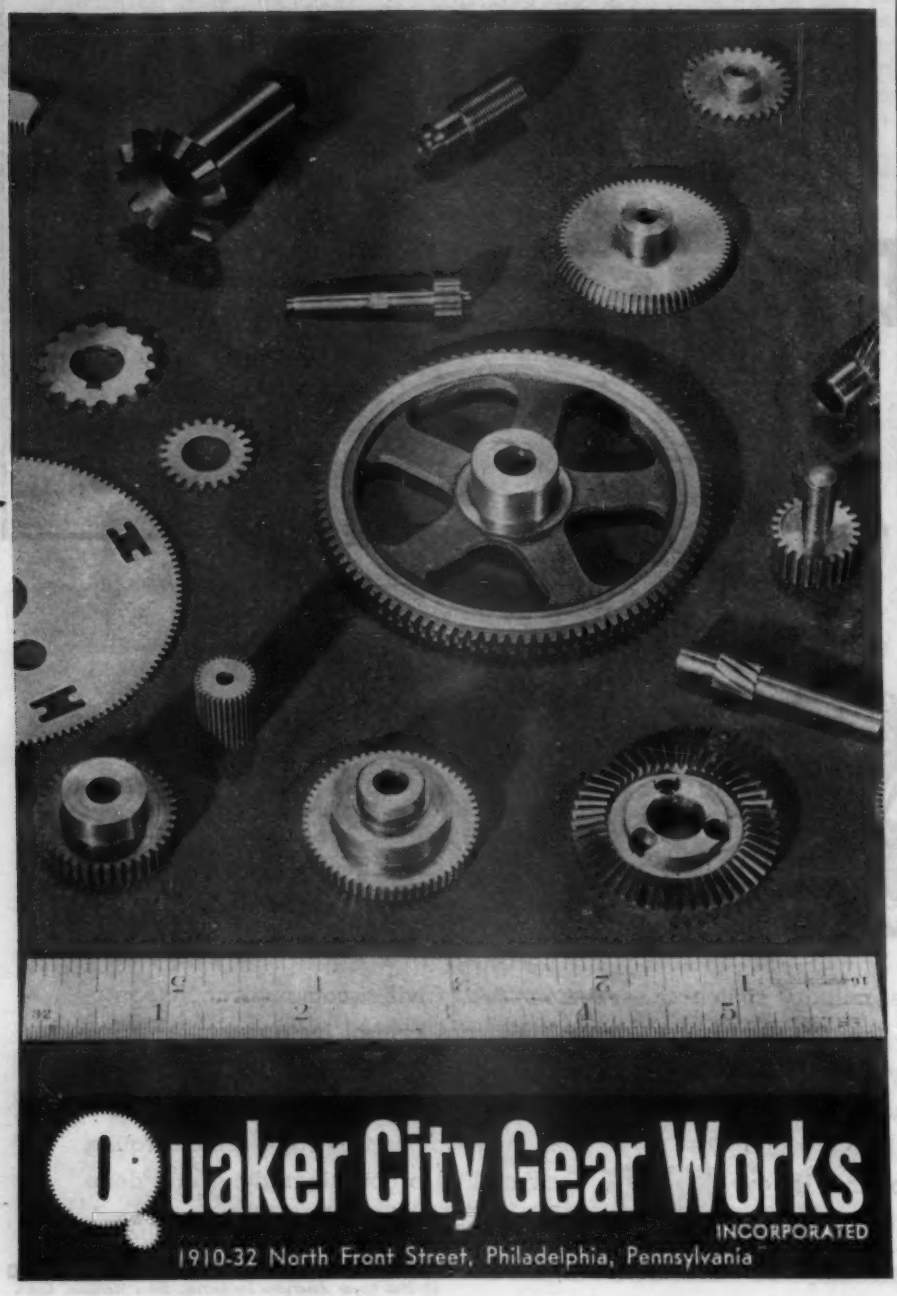
Today: Field telephones, military switchboards, electronic devices, aircraft ignition systems—produced to Army-Navy "E" standards by a group of men and women putting an average of 15% of their incomes into war bonds and proud of one of the lowest percentages of absenteeism in the nation.

Tomorrow: Civilian communications equipment, industrial control instruments, hospital communicating and signalling equipment, and precision electrical products — produced by men and women who are demonstrating their ability to get things done and done right—earning the right to be remembered.

© 1944 Great American Industries, Inc., Meriden, Conn.



Quaker City Gears Are Rolling with Our Armed Forces on All Fronts



Dr. Walter H. Kohl has been appointed chief engineer and vice-president of Rogers Radio Tubes Ltd. of Toronto, Canada.

John Harold Ryan, assistant director of Censorship in charge of radio, has been elected president of NAB to succeed Neville Miller when his term of office expires on June 30, 1944.

Fred D. Williams, past president of RMA, has succeeded Ross D. Siragusa as chairman of the RMA Committee on Industry Statistics. G. W. Henyan, chairman of the RMA Transmitter Division, is a new member of the statistics committee.

W. P. Hilliard, director of Sales and Engineering of the Radio Division of Bendix Aviation Corp. since 1936, has been appointed general manager of the Radio Division, succeeding Hugh Benet who has assumed a special assignment.

J. Kelly Johnson has joined the engineering staff of Hammarlund Manufacturing Co. as executive engineer in charge of all engineering activities.

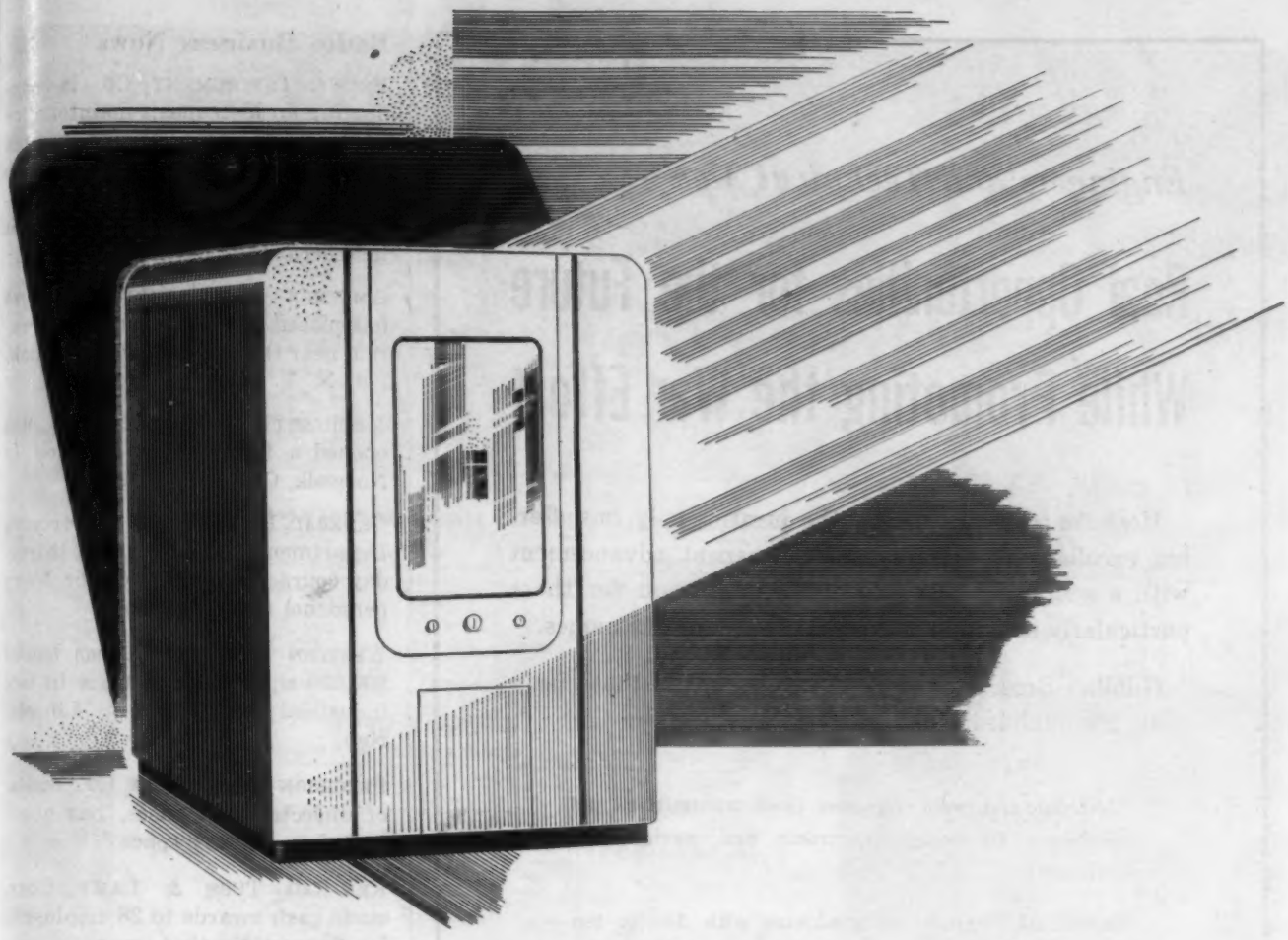
R. L. Anderson has been appointed chief engineer of Franklin Transformer Co. of Minneapolis.

Robert C. Gold, field engineer in Photophone theater equipment installation, has returned to RCA Service Co. headquarters in Camden after spending eight months servicing radio and electronic equipment of the armed forces in North Africa.

Allan B. Chapman, RCA Photophone engineer in Texas, is in Europe on assignment by RCA for installation of ship-borne electronic equipment, in cooperation with the U. S. Navy.

E. D. Van Dyne, field engineer for RCA Service Co., has been appointed a group leader on electronic equipment installation at a U. S. Navy Yard on the Atlantic Coast.

Major W. P. Saunders is on duty in the Office of the Chief Signal Officer, where he was recently promoted to the grade of Major from Captain.



The part you can't see...

Of course you can't even see post war products yet . . . buf when they get here we know they are going to be pretty fine. One reason is that the parts in them will be better due to the precision techniques learned in war.

Rubber parts today are precision made, too. Some of them we make must be accurate to a thousandth of an inch . . . and stay resilient at terrific extremes of temperature and pressure.

Thousands of such small parts make the efficient, unbeatable operation of America's war machines possible . . . all Johnson Rubber production today is for Uncle Sam.

There will come a day, though, when we all have to think about transferring the boys' names from the honor roll to the pay roll, and getting back to our regular job of supplying a peacetime market. To meet that great day with a minimum of time waste is important to the boys coming back . . . and important to you.

Lay your plans now. Let us help you. Johnson engineers and designers can help you solve problems in your post war products . . . and come up with the right answers in the right kind of rubber in the specific part you need . . . and this precision in rubber perfected in wartime will serve you well in peacetime.

We will be ready to supply you when the time comes . . . but the time to think about it and plan ahead is now . . . not then.

Make Rubber Stocks

STRETCH

They are a wartime weapon!

JR

The JOHNSON RUBBER CO. • *Middlefield, Ohio*

MOLDED & EXTRUDED RUBBER PARTS FOR INDUSTRY'S VITAL ASSEMBLIES

Indispensable in War—Essential in Peace

Since 1896

Engineers and Technical Men—

Real Opportunities for the Future While Promoting the War Effort

Here are positions, not for the duration only, but offering excellent opportunity for permanent advancement with a successful and growing organization for those particularly skilled in the latest electronic techniques.

Gilfillan Bros. Inc. of Los Angeles offers these positions for qualified men:

Electronic and radio engineers (both transmitters and receivers) to design electronic and navigational equipment.

Mechanical Engineering graduates with five to ten years' experience in design and layout of light mechanical devices plus shop experience or equivalent.

Men of engineering grade for extensive electronic production and field test operations.

Technical men with ability to write technical material for instruction books and to handle complicated parts lists.

These positions are in essential war work and availability certificates are required.

Write stating qualifications, experience and personal data.

IMPORTANT—Interviews for successful applicants will be conveniently arranged.

In Reply—Refer to: R111—CFW

GILFILLAN BROS. INC.

1815 VENICE BLVD. LOS ANGELES 6, CALIFORNIA

Radio Business News

BROWN INSTRUMENT CO. is conducting an instrument maintenance and repair course designed to meet the requirements of customers who send students to the school to receive continuous-balance instrument instruction.

AMPEREX ELECTRONIC PRODUCTS has placed a second plant in operation near the parent plant in Brooklyn, N. Y.

MACHLETT LABORATORIES, INC. has opened a Power Tube Division in Norwalk, Conn.

GENERAL ELECTRIC CO. Electronics Department is conducting a thirty-day course in electronics for Navy personnel and civilians.

WESTERN ELECTRIC CO. has leased 200,000 sq ft of floor space in two industrial buildings in Lincoln, Neb.

PRECISION PAPER TUBE CO., maker of dielectric coil bases, has quadrupled its factory space.

KEN-RAD TUBE & LAMP CORP. made cash awards to 28 employees for suggestions that improved production and efficiency.

BENDIX AVIATION CORP. has opened an office in the Lincoln Building, 60 East 42nd St., New York 17, N. Y.

ELECTRO PLASTIC PROCESSES of 2035 West Charleston St., Chicago 54, Ill. has taken over the new process of metal plating on plastics, glass, etc. developed by Precision Paper Tube Co.

NORTH AMERICAN PHILIPS CO., INC. has purchased Philips Metalix Corp., maker of x-ray tubes and equipment, and will continue operation as the Metalix Division of the company.

ALLIED CONTROL CO., maker of electrical control devices and fiber lock-nuts, will open a new factory in Chicago.

AMERICAN RADIO HARDWARE CO., INC. has opened a new plant at Mount Vernon, N. Y.

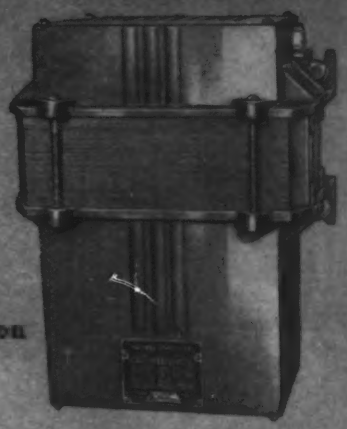
INTERNATIONAL TEL. & TEL. CORP. has appointed four new vice-presidents and four second vice-presidents. The new vice-presidents are: H. C. Roemer, vice-president and

RAYTHEON VOLTAGE STABILIZERS

control fluctuating voltage to ±½%

- Stabilize at any load within their ratings.
- Hold constant varying A. C. input voltage to ± ½%.
- Quick action . . . fluctuating input voltage is stabilized within 2 cycles. Variations cannot be observed on an ordinary volt meter.
- Wide A.C. input voltage limits . . . 95 to 130 volts.
- Entirely automatic . . . no moving parts . . . requires no maintenance . . . connect it and forget it.

Bulletin DL48-537 is new — write for your copy.



CUBICLE MODEL

INPUT 95-130 V 60 CYCLES 1-PHASE OUTPUT 115 V PLUS OR MINUS ½%

WATTS	CASED Cat. No.	CASED Net Wt.	Index Ref. No.	UNCASED Cat. No.	UNCASED Net Wt.
30	VR-1	8 lbs.	G-1	VR-107	6 lbs.
30	VR-1-A†	8 "	G-1	VR-107-A†	6 "
60	VR-2	18 "	G-2	VR-207	16 "
120	VR-3	26 "	G-3	VR-307	22 "
250	VR-4	46 "	G-4	VR-407	36 "
500	VR-5	70 "	G-5		
1000	VR-6	140 "	G-6		
2000	VR-7	200 "	G-7		

†OUTPUT 6.0 or 7.5 VOLTS PLUS OR MINUS ½%.

DIMENSIONS IN INCHES

Index Ref. No.	L 50~	L 60~	W	H
G-5	13 ½	12 ½	9 5/8	8 ½
G-6	14 5/8	14	14 ¾	11 ½
G-7	17 ½	16 ½	14 ¾	11 ½

INPUT 190-260 V 60 CYCLES 1-PHASE OUTPUT 220/230 V ± ½%

WATTS	CASED Cat. No.	CASED Net. Wt.	Index Ref. No.
2000	VR-7-A	200 lbs.	G-7

CASED MODEL

INPUT 95-130 V 50 CYCLES 1-PHASE OUTPUT 115 V PLUS OR MINUS ½%

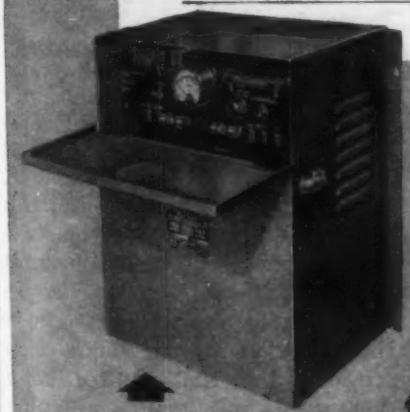
WATTS	CASED Cat. No.	CASED Net Wt.	Index Ref. No.	UNCASED Cat. No.	UNCASED Net Wt.
25	VR-155	8 lbs.	G-1	VR-158	6 lbs.
60	VR-255	21 "	G-2	VR-258	19 "
120	VR-355	26 "	G-3	VR-358	23 "
250	VR-455	50 "	G-4	VR-458	42 "
500	VR-555	80 "	G-5		
1000	VR-655	150 "	G-6		
2000	VR-755	220 "	G-7		

DIMENSIONS IN INCHES

Index Ref. No.	L	W	H
G-1	8 7/8	3 1/8	4 ½
G-2	11 3/8	5 3/8	5 5/8
G-3	15	6	6 1/8
G-4	18 5/8	7	8 7/8

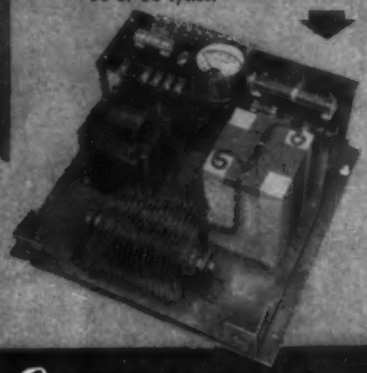
INPUT 190-260 V 50 CYCLES 1-PHASE OUTPUT 220/230 V ± ½%

WATTS	CASED Cat. No.	CASED Net Wt.	Index Ref. No.	UNCASED Cat. No.	UNCASED Net Wt.
25	VR-521	8 lbs.	G-1	VR-510	6 lbs.
60	VR-522	21 "	G-2	VR-520	19 "
120	VR-523	26 "	G-3	VR-530	23 "
250	VR-524	50 "	G-4	VR-540	42 "
500	VR-525	80 "	G-5		
1000	VR-526	150 "	G-6		
2000	VR-527	220 "	G-7		



Raytheon RectiChargeRs (battery chargers) . . . complete range of units from 1 to 12 amps . . . many models for 50 cycles input.

Raytheon RectiFilteRs (battery eliminators) . . . wide range of models available for varied operations . . . 50 or 60 cycles.



UNCASED MODEL

DIMENSIONS IN INCHES

Index Ref. No.	L	W	H Max.
G-1	7 5/8	3	3 5/8
G-2	7 3/8	5 11/16	5 1/8
G-3	12 1/4	5 11/16	5 3/8
G-4	15 5/16	6 3/4	7 -

RAYTHEON MANUFACTURING company

190 WILLOW ST WALTHAM, MASS

The coveted Army-Navy "E", for Excellence in the manufacture of war equipment and tubes, flies over all four Raytheon Plants where over 12,000 men and women are producing for VICTORY.

Yes, this emblem does look like a caduceus, the medical symbol. And that's quite fitting—for Sanborn Company has long been a recognized leader in the medical diagnostic field.

Notice that the nucleus of the design is the electron tube symbol. Around and below it are entwined electronically-produced electrocardiograph records, representing a worthwhile background for our present electronic war work.

(The wing-placed charts depict the metabolism branch of Sanborn's service to the medical profession.)

The gear is so placed in the design to indicate a close affiliation of mechanical with electronic precision.

Such a background, coupled with our present electronic accomplishments and our potentialities are reasons why you might want to know us better.

SANBORN COMPANY
MAKERS OF ELECTRONIC INSTRUMENTS
CAMBRIDGE 39, MASS.

comptroller of Federal Tel. & Radio Corp., affiliate of IT&T; W. H. Freng, assistant general attorney, also appointed solicitor; Charles D. Hilles, secretary of the corporation; and Francis White, vice-president of International Standard Electric Corp., another IT&T affiliate.

The second vice-presidents appointed are F. F. Davis, H. H. Buttner, vice-president of Federal Tel. and Radio Corp., G. A. Ogilvie, Leonard Jacob II.

WHEELCO INSTRUMENTS COMPANY will continue at the same location since purchase by Fred A. Hansen and Cary H. Stevenson, vice-presidents of Lindberg Engineering Co. and several associates. The company will expand in industrial applications of electronics and supersonics.

NORTH AMERICAN PHILIPS CO., INC. has established a new electronics research laboratory at Irvington, N. Y. and appointed Dr. Ora Stanley Duffendack, professor of physics at University of Michigan since 1922, as research director. He has been a director of research with NDRC and serves as chief of one of its sections.

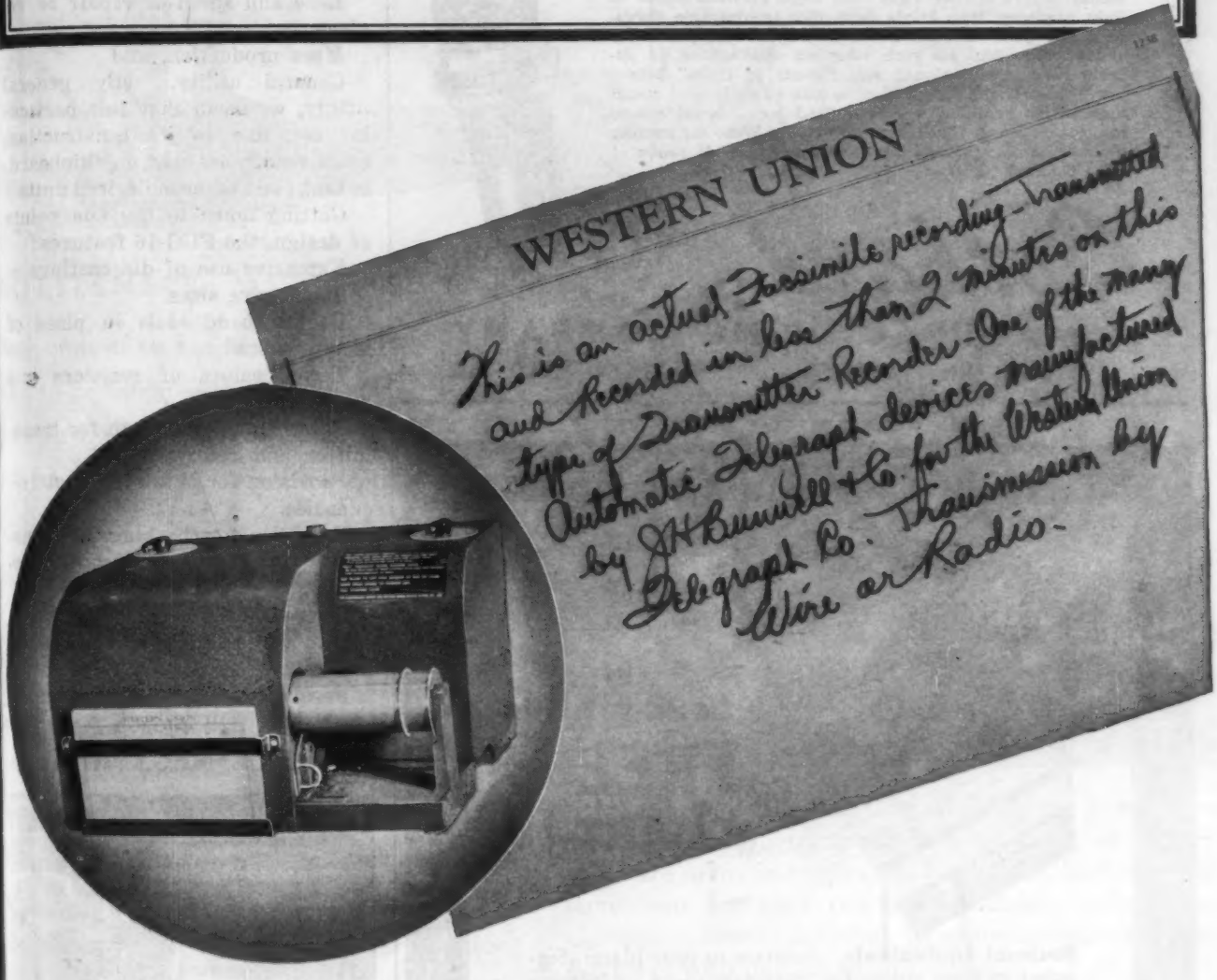
UNIVERSAL MICROPHONE CO., LTD. has become Universal Microphone Company.

E. I. DU PONT DE NEMOURS & CO. is building a plant at Towanda, N. Y. for the Patterson Screen Division to manufacture phosphors of the type previously imported from England.

ZENITH RADIONICS CORPORATION OF NEW YORK has been formed as a subsidiary of Zenith Radio Corp. with offices in the Empire State Building. Zenith president E. F. McDonald, Jr., will also head this new distributing corporation, and H. J. Wines has been appointed general manager. Announcing the new set-up at a press conference in New York in March, Zenith vice-president J. J. Nance stated that a great deal of post-war planning today consists of figuring out how to get into the other fellow's business. He also pointed out that obsolescence is speeded up during wartime, so that there will be a post-war replacement market of 30 to 40 percent of the 60,000,000 radio receivers in homes today.

Facsimile

Tells its own story!


WESTERN UNION
This is an actual Facsimile recording - transmitted and recorded in less than 2 minutes on this type of Transmitter-Recorder - One of the many Automatic Telegraph devices manufactured by J. H. Bunnell & Co. for the Western Union Telegraph Co. Transmission by Wire or Radio -

J. H. BUNNELL & Co.

DESIGNING ENGINEERS AND MANUFACTURERS OF
ELECTRONIC INDUSTRIAL & COMMUNICATIONS EQUIPMENT
GENERAL OFFICES: 215 Fulton St., New York City · FACTORIES at Brooklyn, N. Y.

Dimout
or
Total Blackout

This GOTHARD Shutter Type PILOT LIGHT is available *Either Way!*

Model #1114 Shutter Type Pilot Light provides range of light gradation from bright light, thru intermediate glows, to a dim glow—or *total dark*—within 90° rotation of the shutter. Practical for such vibration applications as aircraft, ships, tanks, signal, etc. Mounts in 11/16" hole—has ½" Jewel and may be had to take either long or round bulb. Also available with polarized lens. Jewel colors: red, green, amber, blue, opal and clear. Write for catalog giving complete information on this and a wide range of other Gothard Lights.

Gothard
MANUFACTURING COMPANY
1310 N. NINTH STREET SPRINGFIELD, ILL.

Send for this
FREE
CHART

Decimal Equivalents. Accurate to four places. Signaled in three colors for maximum speed in locating decimal equivalent of fraction. Saves time and avoids errors. Yours at no cost or obligation. Just send us your name, title and address.

See our Catalog in Sweet's File for Product Designers

JOHN HASSALL, INC.
Specialists in Cold-Forging Since 1850
150 Clay Street • • Brooklyn 22, N. Y.

SPECIAL NAILS RIVETS SCREWS
Hassall

German Radios

(*Continued from page* 134)

airplane, by inserting a test plug in a jack panel provided on the front of both receiver and transmitter. A complete diagnosis of any unit can be made by this means.

Summary of Features

German design for this particular equipment, which is thought to be of 1935 construction, features:

Ease of operation.

Simplicity of control.

Serviceability.

Ease and speed of repair or replacement.

Mass production, and

General utility. (By general utility, we mean that this particular set, due to its construction, could readily be used on shipboard, in tanks and other motorized units.)

Getting down to the fine points of design, the FUG-16 features:

Extensive use of die castings.

Small wire sizes.

Use of band seals in place of lock-washers.

Fewer values of resistors and capacitors.

Fewer tube types, both for transmitter and receiver.

Provision for obtaining spot frequencies.

Provision for checking the transmitter frequency against the receiver.

Color-coded screws to show which screws are to be loosened in removing unit.

Frequency-calibrated dial scales.

• • •

MOBILE MEGAPHONE

To decrease road fatalities in London, pedestrians are directed by an officer with a portable electronic megaphone. This unit can be used while walking with the batteries and amplifier in the carrying case

BOTTLENECK BUSTERS

No. 1 of a Series

The Toy Soldier Caster that went to War

BOTTLENECK:

Both ends of tens of thousands of choke coils had to be solder-sealed. Hand soldering was too slow. Machines were needed to do the job at the rate of several a minute.

HOW BROKEN:

From a Gilbert toy with which small boys cast regiments of tin soldiers, Sickles production engineers designed a device that would do the job. The tin-soldier mold was adapted to mold seals on both ends of the choke coil, simultaneously. The electric melting pot was used, a metering valve was devised, and in a few days, the sealer was in full production. The original sealer and many more like it are in daily service.

American ingenuity like this, all along the production front, is helping to speed Victory. Here at Sickles, there are many examples of "bottleneck busting" that have sent intricate condensers, choke coils, other electronic devices speeding to communications manufacturers who needed them quickly.

If quality and speed are your twin needs, specify Sickles equipment.

THE F. W. SICKLES COMPANY • CHICOPEE, MASSACHUSETTS

ARMY E NAVY

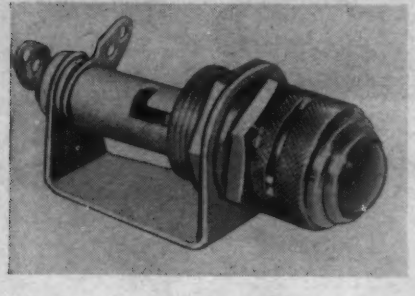
SICKLES *Electronic Specialties*

NEW PRODUCTS

Month after month, manufacturers develop new materials, new components, new measuring equipment; issue new technical bulletins, new catalogs

Dim-Out and Black-Out Pilot Lights

PILOT LIGHTS are available either as dim-out lights or as complete black-out lights. The lights employ two discs, each of which has 3 holes. When the discs are aligned so that the 3 holes in each disc is opposite each other, the pilot light produces a bright light. As the discs are rotated 90 deg, the gradual misalignmnt of the holes slowly reduces the brilliance of the light until it finally reaches a total black-out. If a dim glow is desired instead of a total black-out, a fourth hole is provided in the center of each disc. This fourth hole always allows a small amount of light to seep through.



Gothard variable intensity lights are also available with polarized lenses.

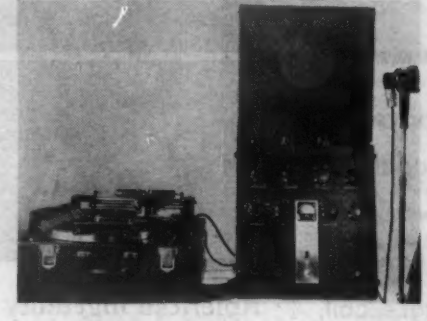
Gothard Pilot Light Co., 1300 North 9th St., Springfield, Ill.

Portable Sound Recording Devices

A RECORDER AND PLAYBACK unit and an amplifier-equalizer are two devices which have been improved over pre-war models and which will be available from the manufacturer in the very near future. The first of these devices is a recorder which uses a new magnetic cutter head and has an improved low-pressure pickup with a choice of crystal or dynamic type. The weight of the equipment has been reduced by approximately 70 pounds. The general vibration level has been reduced by 5 to 8 db.

The equipment may be used either indoors or outdoors though it is designed for portable field service.

It will take direct lateral recordings and will reproduce sound at speeds of 78 rpm or 33.3 rpm and will play back discs up to 16 inches. Cables and plugs provide instantaneous hookup to an amplifier to enable recording or playback. The recording mechanism can select four cutting pitches (either from the inside of the record to the outside or from the outside in) without the necessity of changing feed screws. A push rod on the center pivot of the turntable is used to change the speed of the turntable from 78 rpm or 33.3 rpm. The recorder is equipped with 110–120 volt, 60 cps, synchronous motor which is dynamically balanced. The equipment itself is supplied for operation on 115 volts, 60 cps.



Lower hum and noise level are the main improvements made in the amplifier-equalizer unit. This unit is designed for use in studio recording, playing back records, and PA uses. It is compact and comes in a light guage metal trunk which measures 17 inches wide, 18¼ inches high, 11 inches deep. A boost of from zero to 20 db is available at any frequency from 20 to 100 cps, and from 4,000 to 10,000 cps. It is not necessary to alter the volume or gain of an amplifier in the midst of a recording merely because the equalization is changed. Input plugs are available for a microphone of 50 or 250 ohms impedance, for two crystal pickups of 10,000 ohms impedance, and for a T unbalanced and an H balanced 500 ohm impedance for radio tuner or line from an external mixer. Outputs are provided for two recorders as well as for a T unbalanced and an H balanced 500 ohm output line.

Maximum undistorted output is 12.51 watts from the 500 ohm winding of the T or H position on the output. The noise level below zero level of 0.006 watts at full gain of amplifier with bass and high controls off is —22 db. and the hum level is —40 db. The microphone input positions have a gain of 107 db. Both pickup positions have a gain of 61 db, and both line input positions a gain of 67 db. If the dynamic pickups are used the pickup inputs will be wired for 50 ohm impedance at 170 db. gain.

Fairchild Camera and Instrument Corp., 475 Tenth Ave., New York 18, N. Y.

Electron Microscope Capacitor

THIS 0.01 MFD, 40,000 volt d-c capacitor was built for a special application of the electron microscope. It is capable of continuous operation at 80 deg C and of withstanding total submersion and heavy surges. The case is welded steel measuring 4½ x 5¼ x 7 inches. The case has a stand-off insulator (Westinghouse Solder Seal type) which is soldered directly to the case, eliminating the possibility of oil leakage or the entrance of moisture.

Industrial Specialty Co., 1725 W. North Ave., Chicago 22, Ill.

Geared to exacting laboratory standards

One phase of our production which graphically illustrates the nature of ECA standards is this warplane testing device. For obvious reasons, much about its actual function must remain unsaid. However, we can reveal that it is used in the checking of planes before they leave the ground. The mechanism of this instrument is unusually delicate. Skill and understanding are necessary to fashion the countless wires and components into a harmonious working unit. Here, as in all ECA work, our experiences in the manufacture of specialized radio and electronic test equipment serve to good advantage.

Why the Federal Ballot for Soldiers!

At ECA, we earnestly cooperate with every phase of the war program. We are also conscious of another responsibility to our soldiers, that is, the preservation of their rights. As this is being written, legislation permitting soldiers to vote is under consideration. The Federal Ballot is unconstitutional, it violates states' rights—so some men say. To us, the argument for the Federal Ballot is quite clear. If the government has the power to go into any state and select a man for service, then it should have the equal power to make certain that he can take advantage of his *constitutional* right to vote—in the easiest possible manner. Back the President, the War Department and all others who support the Federal Ballot. There is no red tape wrapped around a bullet. It should not be wrapped around a ballot.

eca

ELECTRONIC CORP. OF AMERICA

45 WEST 18th STREET • NEW YORK 11, N.Y. WATKINS 9-1870

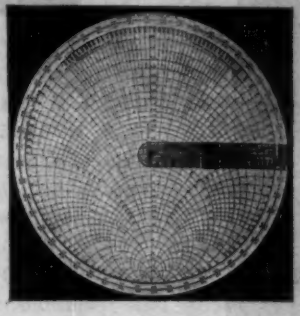
We serve not only as Custom Moulders but also offer complete assembly service. We solicit inquiries on war work and invite consultation on future planning.
For information on our Standard Navy and Maritime Fittings consult Graybar Electric Company.
Northern Industrial Chemical Company
7-11 ELKINS ST., SO. BOSTON 27, MASS.
35 YEARS OF PLASTIC MOLDING EXPERIENCE

MEMBER OF THE SOCIETY OF THE PLASTIC INDUSTRY

CABINETS
CHASSIS
PANELS
RACKS
Skill in Metal
Serving the Electronics Field Exclusively
Write for Catalogue No. 41-A
Though manufactured by modern high-speed methods, Par-Metal products have a definite quality of craftsmanship — that "hand-made" quality which is born of years of specialization
PAR-METAL PRODUCTS CORPORATION
32-62—49th STREET . . . LONG ISLAND CITY, N. Y.
Export Dept. 100 Varick St., N. Y. C.

Transmission Line Calculator

IN THE JANUARY 1944 issue of ELECTRONICS there appeared an article and a cut-out form of an improved transmission line calculator which was an extension of the



"calculator" originally published in the January 1939 issue of ELECTRONICS and for which many requests have been received. Now this new and improved calculator from February issue is available separately as a chart. It is available for $5,00 from The Emeloid Co., Inc., Arlington, N. J.

Hermetically Sealed Transformer

TYPE S IS AN ADDITION to the manufacturer's line of transformers which utilize the "Vac-sealing" im-

pregnation process to insure impregnation. It has a case of cold drawn copper cadmium plated steel to insure ruggedness. The terminal of the unit is molded into a plastic block which has a metal flange molded into its periphery. This flange is then soldered into the case. The manufacturer states

rods
tubes
shapes
tapes

RIGID... to FLEXIBLE...

Compounders and Extruders of Specific Materials for Specific Uses

Synflex Compounds as developed in our own laboratories are produced only in the form of rods, tubes, shapes, tapes and elastics. These distinguished materials meet and surpass the most exacting requirements of the electrical and aviation industries. Many formulations are available, each for a specific job.

Synflex FT 10 is used for the lowest temperature applications, retaining its flexibility to −85 F. Synflex FT 11, a transparent material, is effective in a wide range of working temperatures from −60 F. to 188 F. Synflex FT 22 has a high dielectric strength and for many applications supplants varnished tubing and sleeving.

Synflex rubber-like Tubings are in continuous lengths from B. & S. #24 (.021 I.D.) to 2.000" I.D. Special sizes and shapes upon request.

Inquiries invited. We will gladly submit complete test methods, data and samples.

SYNFLEX

INDUSTRIAL SYNTHETICS CORPORATION

60 WOOLSEY STREET, IRVINGTON, NEW JERSEY

U. S. Army's Heavy 60-ton tank

Are You Ready?

WHILE it would be a mistake to put aside important war work, yet even as with the governments of our country and our allies, it is necessary NOW to spend some time on post-war plans and products. Industry must be ready when the time comes to absorb millions of our returning heroes.

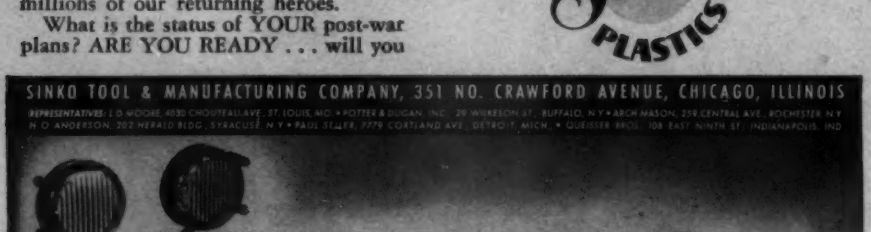
What is the status of YOUR post-war plans? ARE YOU READY . . . will you be among the first to hit the market between the eyes with a product that fits the future? Will YOU survive the *new* competition in *your* field, created by reconversion of vast war plants to producing the products of peace.

Sinko plastic engineers are eminently fitted with ingenuity, skill and long experience to lend you effective aid in applying all the beauty, color and strength of economical THERMOPLASTICS to your products. Let them study your post-war plans . . . help you NOW through the drawing board stage. Be ready to act quickly . . . to get the jump on competition the moment we get the signal to GO AHEAD!

INJECTION MOLDED Sinko PLASTICS

SINKO TOOL & MANUFACTURING COMPANY, 351 NO. CRAWFORD AVENUE, CHICAGO, ILLINOIS

REPRESENTATIVES: J. D. MOORE, 4630 CHOUTEAU AVE., ST. LOUIS, MO. • POTTER & DUGAN, INC., 29 WILKESON ST., BUFFALO, N. Y. • ARCH MASON, 259 CENTRAL AVE., ROCHESTER, N. Y. • H. O. ANDERSON, 202 HERALD BLDG., SYRACUSE, N. Y. • PAUL STAFF, 7779 CORTLAND AVE., DETROIT, MICH. • QUEISSER BROS., 108 EAST NINTH ST., INDIANAPOLIS, IND.



HERCULES

TRANSFORMERS

COILS . . .

MEET ALL SPECIFICATIONS

Prompt Engineering Service always available

DC and AC WELDERS
TRANSFORMERS • MAGNETIC CLAMPS • SOLENOIDS • RIVET HEATERS • SPOT WELDERS • FLUORESCENT BALLASTS
SPECIAL CONTROLS

HERCULES ELECTRIC & MFG. CO.
INCORPORATED
2416 ATLANTIC AVENUE ★ BROOKLYN 33, N. Y.

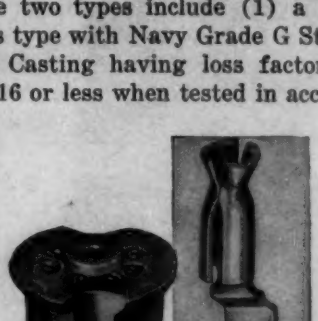
Hercules

this new construction offers great flexibility in number and arrangements of terminals.

Peerless Electrical Products Co., 6920 McKinley Ave., Los Angeles 1, Cal.

Miniature Tube Sockets

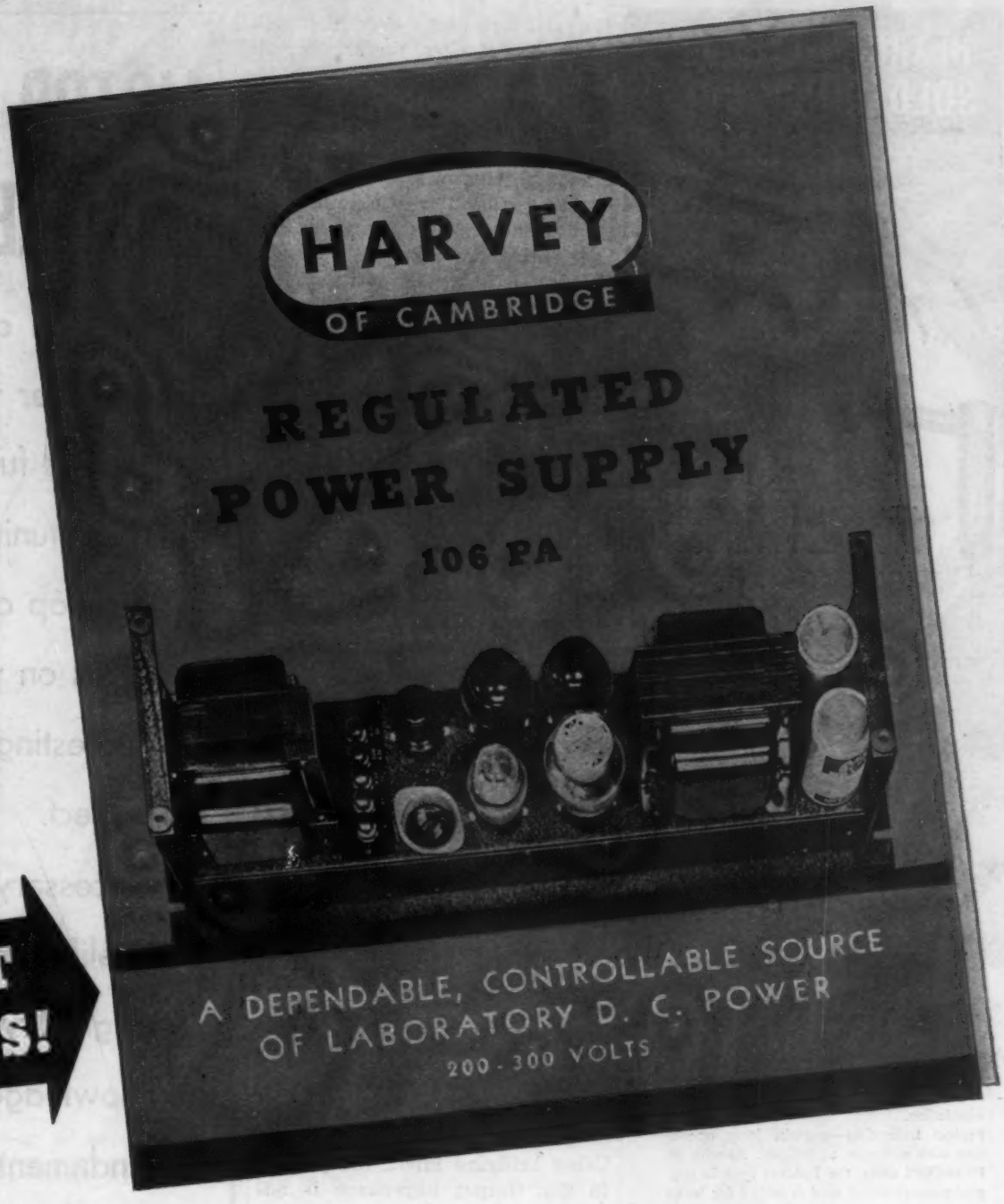
TWO TYPES OF MINIATURE tube sockets (designed and developed at the Signal Corps Laboratories) incorporate "Micro-Processed" beryllium copper contacts which assure constant, even pressure on all parts of the socket pin without fatigue in the contacts after continuous use. The two types include (1) a low-loss type with Navy Grade G Steatite Casting having loss factor of 0.016 or less when tested in accordance with ASTM D 150-42T. Its capacity is 1.5 mmf or less at 10 Mc. The second type is a general purpose type with mica filled plastic casting having a loss factor of 0.05 or less when tested in accordance with the ASTM standard mentioned previously. Its capacity is 5 mmf or less at 10 Mc. The sockets will withstand humidity cycle; immersion; shock; vibration; and thermal shock.



Hugh H. Eby, Inc., 18 W. Chelten Ave., Philadelphia 44, Pa.

Flow Rate Alarm

A NEW FLOW RATE METER may be used by broadcast stations for protecting transmitter tubes against cooling water failure, or the meter may be used in other applications as a means of visible and audible protection against dangerously low or high flows of liquids and gases. This alarm is known as Rota-Sight Flow Rate Alarm. It operates through a float which moves up and down a pyrex tube into which tri-



GET THIS!

Reading time only two minutes, yet this boiled-down bulletin on the HARVEY Regulated Power Supply gives you all the answers on a dependable source of D. C. power. You'll want it for reference whether or not you have immediate use for a controlled power supply.

It's yours for the asking. Just jot down your name, position and company address and say, "Send me the bulletin on the HARVEY Regulated Power Supply."

Write to

HARVEY
OF CAMBRIDGE

HARVEY RADIO LABORATORIES, INC.

439 CONCORD AVENUE · CAMBRIDGE 38, MASSACHUSETTS

HEXACON ELECTRIC SOLDERING IRONS

Expressly designed for the multitude of complex and tedious soldering requirements, the HEXACON Hatchet Type soldering iron has found extensive use because of its extreme ease of manipulation.

Perfect balancing—permits long operation with minimum of fatigue. As with all HEXACON units, the Hatchet type is ruggedly constructed, and is tested for twice the intensity required by the Underwriters' Laboratories, assuring greater-than-average service life with economy and efficiency. Operates on AC or DC of any cycle, and is available in voltage ranges from 32 to 250 volts. Equipped with replaceable elements, and all other features of HEXACON Plug Tip Irons.

WRITE FOR LITERATURE

Descriptive bulletins, describing the complete line of HEXACON electric soldering irons, will be sent on request.

HEXACON ELECTRIC COMPANY

130 W. CLAY AVE., ROSELLE PARK, N. J.

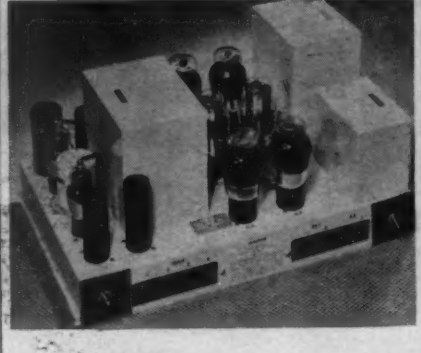
HEXACON

angular flutes have been fashioned. As the float rises, the area within the flutes increases, causing the float to assume a position in the tube in direct proportion to the flow rate. A magnetic extension on the float trips an external switch to operate the alarm circuit. The alarm flow point is adjustable over the entire flow range and operates accurately at the set position. It is built in sizes up to 2½ inches and may be obtained in any corrosion-resistant metal that can be cast.

Bulletin 92-B with full description is available from the manufacturer, Fischer & Porter Co., 9111 County Line Road, Hatboro, Pa.

Amplifier

TYPE 101-A AMPLIFIER has as its outstanding virtue good low-frequency wave form at high output levels. The volume range (inherent noise level) is rated 68 db unweighted below full output of +47 vu at 2 percent rms harmonic distortion. With the input impedance



of 600 ohms, the gain is 60 db. Using bridging input, the gain is 46 db. Output impedance is adjustable 1 to 1000 ohms. Gain versus frequency and power output versus frequency characteristics are available upon request from the manufacturer. The Langevin Co., Inc., 37 West 65th St., New York 23, N. Y.

Winding-Insulation Tester

A NEW ELECTRONIC winding-insulation tester for production-line testing of faulty insulation and winding dissymmetries in motors, generators, coils, and transformers employs the principle of balance and comparison. The instrument simultaneously tests turn-to-turn,

MOTOR ENGINEER

Position open for engineer who desires full opportunity to develop own ideas on very interesting new project.

Necessary qualifications: originality, sound knowledge of fundamentals, and experience in electronic motor design.

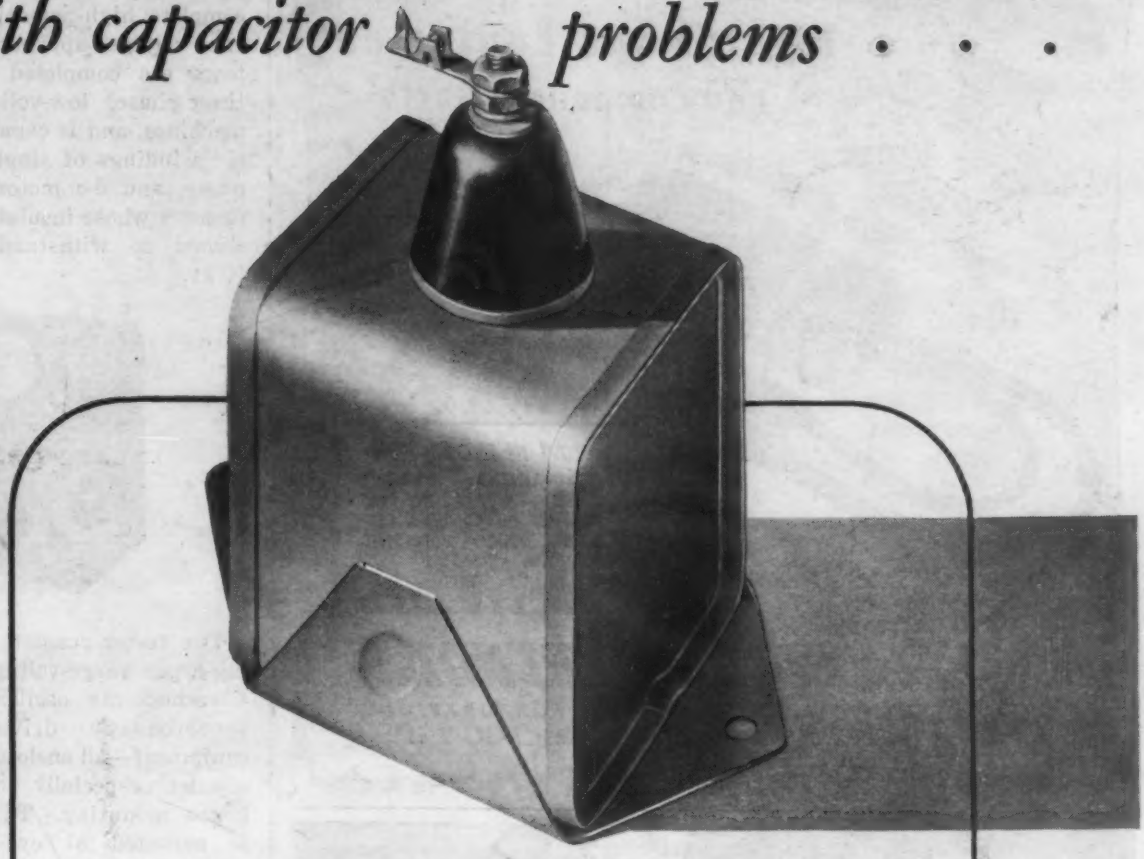
Salary open.

RAYTHEON MFG. COMPANY

PERSONNEL DEPARTMENT

WALTHAM, MASSACHUETTS

Here's How Micamold Helps Project-Engineers *with capacitor problems . . .*



Several thousand transmitting mica capacitors were needed for an imperative wartime function

***Micamold* engineers analyzed the specifications of the mica condenser. They found that a similar type could be built—*without using strategic and costly mica*. This *Micamold* Paper Capacitor is the result.**

The Micamold-created Paper Transmitting Capacitor is mechanically interchangeable with its mica counterpart . . . and serves its purpose in the particular application for which it was designed. Thousands of pounds of precious mica were saved and production costs were greatly lowered.

IF YOU HAVE A CONDENSER DESIGN PROBLEM, CALL ON MICAMOLD

Micamold is equipped to help you with your capacitor problems and to manufacture a wide variety of standard or special types to suit your requirements. Collaboration between project engineers and our own staff has broken many a "bottleneck" We would like to work with you on present or postwar projects.

MICAMOLD RADIO CORPORATION
1087 FLUSHING AVENUE BROOKLYN 6, N. Y.

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Interphone Equipment
and Component Parts

NOW IN PRODUCTION

CD-318-A	JK-48	PL-68
CD-307-A	PL-47	"A" Plug
CD-874	PL-54	BC-366
JK-26	PL-55	BC-347-C
PE-86	SW-141	
JB-47	TD-3	

TRAV-LER KARENOLA
RADIO AND TELEVISION CORPORATION
1030 W. VAN BUREN ST., CHICAGO 7, ILL.

*AFTER VICTORY

You'll Broil Your Steaks by Radio!

SIMPLE as a waffle-iron, easy as tuning in your favorite radio station, your steak-broiler of tomorrow will use short wave radio waves to give you as succulent a dish as you've ever tasted.

But this radio-steak-broiler, like countless other precision products planned for the future, will depend on parts of exacting precision.

With the techniques we have developed in the last 30 years, plus the new skills war has taught us, we can now *mass-produce* close-tolerance parts at a fraction of their cost a generation ago.

New millions will share, After Victory, in these advancements, the production of which will provide comfort and security for the millions now working and fighting for that better tomorrow.

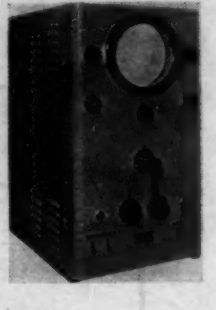
(*Below*) A few of the many thousands of our precision-made parts that are helping bring Victory closer, and which will help mould our world of tomorrow.

ERICSSON
ESTABLISHED 1911

Let's all back the attack • Buy Extra War Bonds

ERICSSON
SCREW MACHINE PRODUCTS CO., INC.
25 LAFAYETTE STREET BROOKLYN 1, N. Y.

coil-to-coil, and coil-to-ground insulation. It simulates qualitatively such procedures as resistance, impedance-balance, turn-balance, and complete high-potential tests with one voltage application. It also tests the completed windings of three-phase, low-voltage rotating machines, and is capable of testing the windings of single-phase, two-phase, and d-c motors and transformers whose insulation is not designed to withstand more than 10 kv.



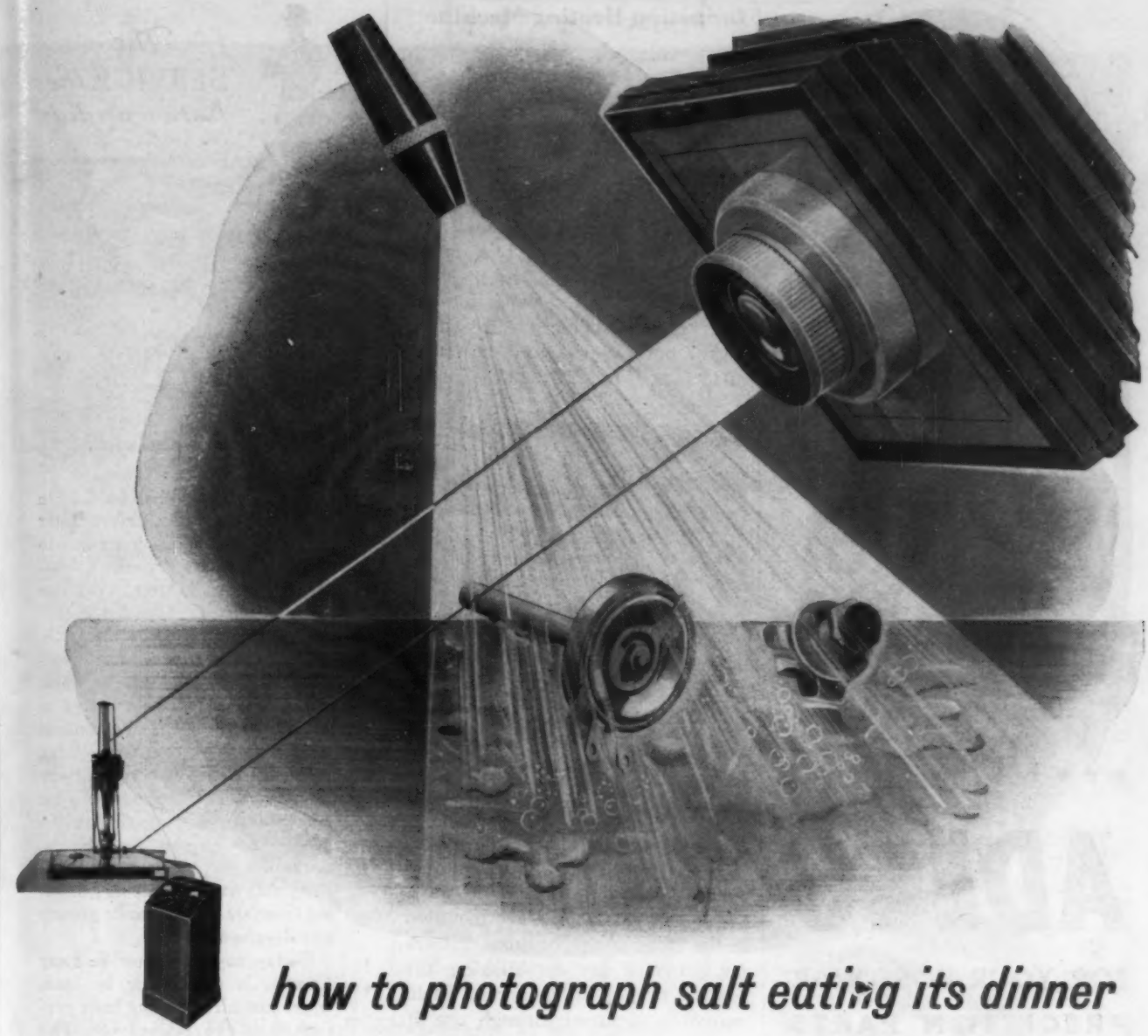
The tester consists of a repeating-type, surge-voltage generator, a cathode-ray oscilloscope, and a synchronously driven switching equipment—all enclosed in one steel cabinet especially designed for bench mounting. The oscilloscope is mounted at eye-level height, where it can be seen easily by the operator, and all the controls are conveniently arranged. Adequate safety portection has been built into the equipment.

General Electric Co., Special Products Div., Schenectady, N. Y.

Multi-Circuit Switch

THIS NEW MULTI-CIRCUIT switch weighs three ounces and comes in a sturdy frame which is molded of high-impact phenolic which conforms to Navy specifications. Knurled inserts with full ¼-inch depth of thread are provided (on ⅝ x 1¼ inches centers) and are locked in place so they cannot twist or pull out. Coin silver contacts carry 10 amps a.c., or 2 amps d.c. current, at 115 volts. The contacts may be ganged in any desired number and combination or they may be used for locking or spring-return in either lever position.

Bulletin A-422 gives complete information and is available from Metallic Arts Co., 243 Broadway, Cambridge, Mass.



how to photograph salt eating its dinner

Salt, from the sea and air, has a tremendous appetite for many metals—eating them away unless they're protected. The exact effect of its gluttony and the success of the means used in preventing this costly damage are measured accurately by Utah's salt-spray test. One of the stages in Utah's *complete* circuit of radio and electronic tests.

Immediately after the parts have been subjected to the salt spray, microphotographs are taken and developed in the especially equipped Utah dark room. Thus, it is possible to make a microscopic inspection of the actual condition of the metal *before* other atmospheric changes take effect. Since metal surfaces exposed to salt-spray tests change rapidly *after tests are completed*, it is necessary and possible, by this photographic method, to determine and *accurately* record corrosion in metals.

As a result of this and other Utah tests, efficient performance of Utah parts is assured under any and all conditions normally encountered—the failures due to inadequate, inaccurate testing are avoided.

★ ★ ★

Every Product Made for the Trade, by Utah, Is Thoroughly Tested and Approved

Keyed to "tomorrow's" demands:
Utah wirewound controls, switches, plugs,
jacks, vitreous enamel resistors, transformers, vibrators, speakers.

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ADECO

FOR YOUR POST-WAR PRECISION PARTS AND ASSEMBLIES

Adeco offers you a dependable source of supply with the know-how, experience and complete facilities for all types of close-tolerance production. It will pay you to include Adeco fabrication in your post-war plans.

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4401 North Ravenswood Avenue
CHICAGO 40, ILLINOIS

"Your Partners in Production"

Induction-Heating Machine

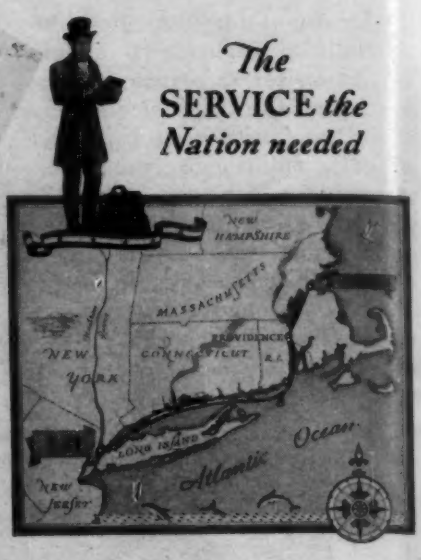
THIS COMPACT INDUCTION motor generator unit is designated as "Tocco Junior" and is a 15 kw output, 9600 cps high-frequency unit useful for a wide-range of heat treating applications such as brazing, annealing, heat-treating and surface hardening of small and medium-sized parts. The generator is driven by a 25 hp, 3 phase, 229–440 volt motor. Capacitors for power factor correction are an integral part of the unit. Controls and four high-frequency instruments (voltmeter, ammeter, wattmeter and var-meter) are mounted on the front of the machine. Timers are provided for establishing the heating or hardening cycles. Field control is obtained through use of a variable voltage transformer operating in connection with selenium rectifiers for obtaining field excitation. Inductors for brazing are designed to treat more than one size of tip. These coils are sturdy, shock resistant and water cooled. The unit measures 43 x 32 x 51 inches and can be easily fitted into a production line.

Other 9600 cps Tocco Junior models available come in ratings of from 7½ to 125 kw ratings, and 200 kw at 3000 cps.

The Ohio Crankshaft Co., 3300 Harvard Ave., Cleveland 1, Ohio.

Tubular Steel Telescopic Radio Mast

A TELESCOPIC 90-FOOT radio mast, designated as "Harco" Speed King, is designed to withstand a wind



The **SERVICE** *the Nation needed*

SET TO GO, but held by a brake. Goods ready to move faster and surer, but no adequate way to do it. That was America's business situation in 1839. William Harnden had the idea for a railway express service. "I'll carry your goods for you," he advertised to Boston and New York. And he did, at *passenger speed* in a wooden car between Boston and Providence which was where the railroad ended; and between there and New York by steamboat. That was the transportation service idea people and business needed. And as the idea grew, it helped broaden our young nation, unite its spreading frontiers and hasten its growth and development.

Today, 105 years later, Railway Express is performing by land, water and air the same basic personalized express service. The goods it carries now are mostly war materiel. In peacetime, they will again encompass every conceivable personal item as well as the products of industry.

You, as a shipper, can help us carry our share of America's wartime transportation load and serve you better by doing two simple things. Pack your shipments securely . . . address them clearly. Our century of experience proves that "a shipment started right is half-way there!"

RAILWAY EXPRESS AGENCY

NATION-WIDE RAIL-AIR SERVICE

MOTHER'S ON THE PLASTIC FRONT

Remler worker removing threaded ear pieces for telephone hand set from plastic molding press.

A VARIETY OF TASKS in all departments of the Remler Company are performed by women. Their dexterity and painstaking attention to detail contribute to the precision accuracy of Remler components and communication equipment. • Like their sister workers in factories all over the country, many of these Remler women also have the responsibility of managing a household. To this double task they bring a devotion worthy of their menfolks in the fighting fronts. Hats off to the women of America!

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SINCE 1918

Announcing & Communication Equipment

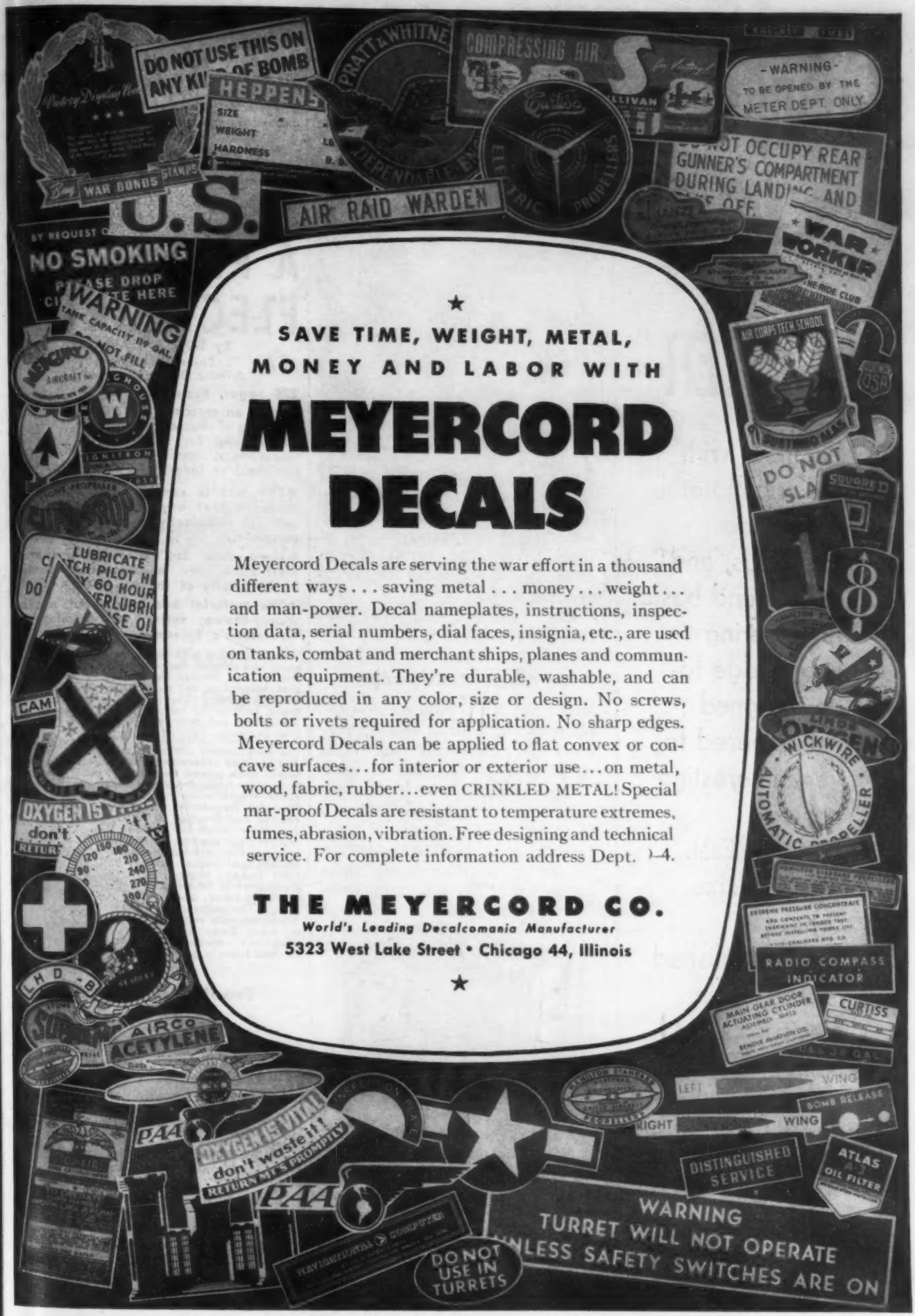
PLUGS & CONNECTORS

Signal Corps · Navy Specifications

Types:		PL			NAF
50-A	61	74	114	150	
54	62	76	119	159	
55	63	77	120	160	1136-1
56	64	104	124	291-A	
58	65	108	125	354	No.
59	67	109	127		212938-1
60	68	112	149		

PLP		PLQ		PLS	
56	65	56	65	56	64
59	67	59	67	59	65
60	74	60	74	60	74
61	76	61	76	61	76
62	77	62	77	62	77
63	104	63	104	63	104
64		64			

OTHER DESIGNS TO ORDER



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SAVE TIME, WEIGHT, METAL, MONEY AND LABOR WITH

MEYERCORD DECALS

Meyercord Decals are serving the war effort in a thousand different ways . . . saving metal . . . money . . . weight . . . and man-power. Decal nameplates, instructions, inspection data, serial numbers, dial faces, insignia, etc., are used on tanks, combat and merchant ships, planes and communication equipment. They're durable, washable, and can be reproduced in any color, size or design. No screws, bolts or rivets required for application. No sharp edges. Meyercord Decals can be applied to flat convex or concave surfaces . . . for interior or exterior use . . . on metal, wood, fabric, rubber . . . even CRINKLED METAL! Special mar-proof Decals are resistant to temperature extremes, fumes, abrasion, vibration. Free designing and technical service. For complete information address Dept. J-4.

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YOU don't need tools to replace the lamp in this new DRAKE No. 85 Jewel Light Assembly. For the jewel holder or bezel can be removed and replaced with the fingers. A simple locking device makes the unit vibration and shock-proof. 3 fibre washers compensate for various panel thicknesses. Washers can be eliminated on ¼" panels, thereby making the lamp as accessible as when the unit is used on 1/16" panels. Other big features are: 1. Complete, uniform illumination over the entire jewel area; 2. Complete blackout, not a pinpoint of light showing. A simple, easy quarter turn to left and right produces these changes. Our newest catalog is just off the press!

DRAKE

PILOT LIGHT ASSEMBLIES

DRAKE MANUFACTURING CO.

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Leakproof

ENAMELED
MAGNET
WIRE

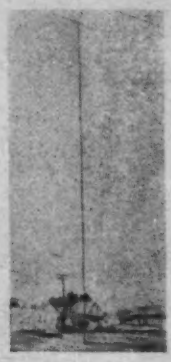
A product, resulting from many years of research in the field of fine wire manufacture, that meets the most rigid requirements of radio and ignition coils. A new coating method gives a smooth, permanently-adherent enameling, and mercury-process tests guarantee perfect uniformity. Great flexibility and tensile strength assure perfect laying, even at high winding speeds. If you want reduction in coil dimensions without sacrificing electrical values, or seek a uniform, leakproof wire that will deliver extra years of service, this Hudson Wire product is the answer.

QUALITY
UNIFORMITY
SERVICE

Also manufacturers of high grade cotton and silk covered wires, cotton and silk coverings over enamel coated wires, and all constructions of Litz wires. A variety of coverings made to customers' specifications, or to requirements determined by our engineers. Complete design and engineering facilities are at your disposal; details and quotations on request.

Winsted
HUDSON WIRE CO.
Division
WINSTED • CONNECTICUT

pressure of 125 miles an hour. It can be erected from ground anchors to top cross-arm in approximately one hour without the aid of trained riggers. The mast is also available in heights from 25 feet up to 200 feet. Is is completely self-contained, portable, and light weight and is suitable for erection on buildings, as well as on the ground.



It may be used as a single unit or two or more masts may be set up as a multiple unit for various types of antennas. Insulators may be placed at any connection joint or at the base. The addition of small auxiliary connectors make the mast suitable for use as a vertical radiator.

Basic in the design is the use of light-weight steel tubing. Connecting the section is accomplished by the use of tapered bars and wedges. The smallest section of the 90-foot mast measures 3¼ inch in diameter, and the sections increase to 4½ inches in the center. The unit (complete with cross-arm of approximately 8 feet) weighs 750 pounds.

Harco Steel Construction Co., 1180 E. Broad St., Elizabeth, N. J.

Transmitting Triode Tubes

THESE TWO NEW HIGH-POWER triodes may be used at maximum ratings at frequencies as high as 5 Mc and with reduced ratings up to 25 Mc. Type 9C21 is a water-cooled type and Type 9C22 is a forced-air-cooled-type. Both are for use in the class B modulator stage and in the plate-modulated class C final amplifier stage of high-power transmitters. They may also be used in large units for industrial r-f heating applications. Two separate bulletins describing these tubes are available from RCA Victor Division, Harrison, N. J.

CHECK THESE SPECIFICATIONS WITH YOUR REQUIREMENTS

1. General—Designed to conform to "American War Standards C 39.2—1944" for Electrical Indicating Instruments.
2. Size—2½", Round, Flush Mounting, Panel Type.
3. Case—Standard case is of moulded bakelite. Available also in metal (brass) case.
4. Solid alloy-steel magnet (not laminated).
5. Range—Available from 0-200 micro-amperes to 0-10 amperes, or 0-1.0 volt to 0-200 volts.

Expanding production now enables G-M to accept a few volume contracts for meters conforming to the specifications outlined above.

Early in the war G-M converted its civilian production of instruments to volume production of war meters. For one aircraft application alone G-M has supplied over 100,000 meters.

Write or wire today for complete details concerning early deliveries on volume orders.

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G-M LABORATORIES INC.

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Buy WAR BONDS & STAMPS

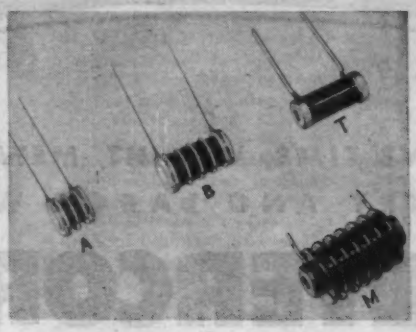
Opening for MOTOR ENGINEER

Engineer with electric motor experience, ingenious, and with sound basic engineering knowledge to be assigned unhampered to very interesting project. Location East. Medium size concern with established reputation in electronics field. Salary commensurate with ability.

P-629, Electronics
330 West 42nd St.
New York 18, N. Y.

Wire Wound Resistors

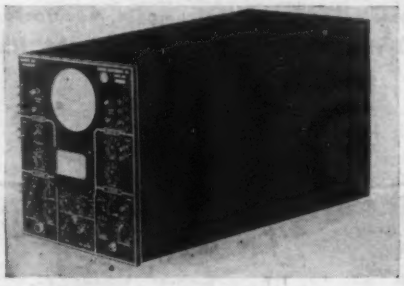
FOUR DIFFERENT TYPES of wire-wound resistors (A, B, M and T) have been recently announced. Types A and B are non-inductive pie-wound and are rated at ½ percent accuracy. Type M is non-inductive wound and Type T is inductive wound. Types T and M are rated at 1 percent accuracy. Ratings are: A ½ watt; B 1 watt; M 1½ watt; and T 2 watts. All of these types are rated at 100 deg maximum operating temperatures and all of them have baked varnished finishes. Resistance varies for the individual units.



Elco Resistors Co., 114 West 18th St., New York 1, N. Y.

Wide Range Oscilloscope

MODEL 556 IS A 5-INCH oscilloscope, equipped with a direct-reading voltmeter for measuring the input signal, and is designed to make measurements at higher frequencies. The sweep generator has a frequency range of 20 cps to 1 Mc. The horizontal amplifier, as well as the vertical amplifier, is practically flat to 2 Mc. The Z-axis amplifier,



which is rated up to 6 Mc, permits blanking and marking. A comparison voltmeter is incorporated to increase the usefulness of the instrument and requires no additional equipment to determine the value of the signal.

Reiner Electronics Co., 152 West 25th St., New York 1, N. Y.

How the electron works for you

Here is the kind of book you have been awaiting—an ABC book which will show any electrical worker or salesman of electrical supplies what electronics is all about. This book gives you simply—without formulas or much mathematics just what you want to know about electronic principles and how they are applied in working devices.

Just Published

A PRIMER OF ELECTRONICS

By DON P. CAVERLY

Commercial Engineer, Sylvania Electric Products, Inc.

235 pages, 5½ x 8½, illustrated, $2.00

Here is an especially clear and simple explanation of electronics and electronic tubes and circuits, for all concerned with the manufacture, application, or operation of household or industrial electronic devices.

- **The text is concise and written in language that anyone can understand, yet is technically authoritative and complete.**
- **More than 200 specially prepared illustrations are an important factor in the clarity of the treatment.**
- **The material has grown out of the widely-known series of articles in *Wholesaler's Salesman*.**

The book begins with the atom, the electron, and static and electron discharges and takes the reader step by step through explanation of electric current, magnetism, and electromagnetic radiation, to an understanding of simple radio tubes, fluorescent lamps, cathode ray tubes, ignitron, thyratron, and other tubes and their basic connections for practical purposes.

The book covers concisely, practically, so that any one may understand, such topics as: production of radio waves; reception of radio waves; short-wave radio; frequency modulation; television transmission; television reception; ultra-high frequencies and microwaves; ranging and directing by radio; infra-red; ultra violet; hot cathode fluorescent light sources; fluorescent-lamp circuits; cold cathode fluorescent light sources; bactericidal tubes; strobotrons; photo-electric tubes; cathode-ray tubes; iconoscopes; image-dissector tubes; facsimile recorder tube; X-ray tubes; electron microscope; electron tubes in general.

See it 10 days on approval

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ELECTRONIC TUBE
TUNGSTEN LEADS,
BASES, CAPS, METAL
SPECIALTIES ETC.,
AND MACHINES
DANIEL KONDAKJIAN components offer exceptional functional advantages born of over twenty years experience in this highly specialized field.
Micro accuracy, consistent high quality, fine finish and rugged durability are inherent mechanical features embodied in their design. Economies, efficiencies and ingenious production methods are intangible but ever present features in their manufacture.
THE DANIEL KONDAKJIAN SPOT WELDER offers production advantages derived from more than 20 years in the field. Compact and efficient, this specialized equipment is precision-perfected for dependability even under severe, continuous operation.
THE ENGINEERING CO.
27 WRIGHT STREET, NEWARK 5, NEW JERSEY
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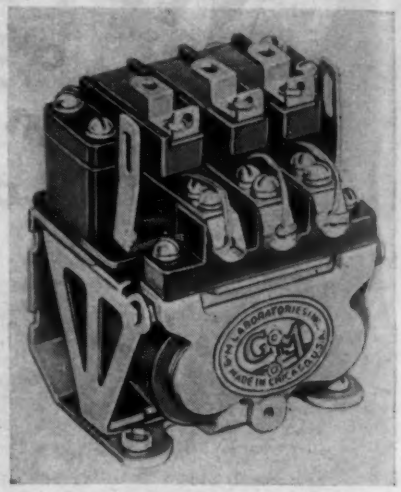
Power Relays for Electronic Circuits

TYPE 27 SENSITIVE POWER relays are designed for use in electronic circuits which require small multipole relays, and on aircraft and mobile equipment where vibration is encountered. Contact blades are shimmed to the correct adjustment to do away with bending of any of the metal parts and to retain the original metal structure. General



specifications of the Type 27 relays are: Sizes of 1, 2 and 3 pole relays measuring approximately $1\frac{1}{2}$x$1\frac{11}{16}$x2 inches. Five pole relays measuring approximately 2x$2\frac{1}{2}$x$2\frac{1}{8}$ inches. Weigh $4\frac{1}{2}$ to $6\frac{1}{2}$ ounces; vibration and acceleration, 10 g; contact capacity up to 10 amps depending on available power and on coil and circuit characteristics; contact pressure 30 to 50 grams.

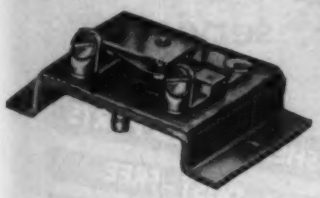
G-M Laboratories Inc., Chicago, Ill.

Recording Paper

ELECTRIX is an electrically marking recording paper requiring no processing either before or after use, and providing a highly legible black permanent mark wherever electric current passes through it between the stylus and the backing contact plate. It comes in rolls, sheets, and discs, with widths ranging from $\frac{1}{2}$ inch to 26 inches. Little or no stylus pressure is required. Current and voltage values needed are dependent upon paper speed, stylus motion and stylus pressure, with normal current ranges being 5 to 40 ma and normal voltage ranges being 60 to 150 volts. The speed of recording is exceeded only by photosensitive papers. Finished

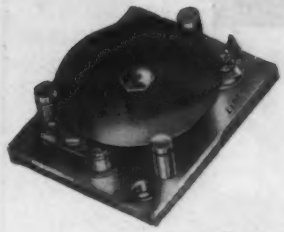
WHEN YOU WANT *Accurate Control*

USE KLIXON SNAP-ACTING CONTROLS



Type C-4351 Series
Used for Tube Warming, Tube Cooling, and High-Low Limit Controls, etc.

Type C-2851 Series
Used as Roughing Controls on Outer Crystal Ovens



Type B-3120
Crystal Dew Point Control

Type PM
(NAF-1131)
Circuit Breaker

Type RT
Adjustable Crystal Temp. Oven Control

Type C-6363
Switch Circuit Breaker

Type ER Series
Ambient Compensated Time Delay Relays

There are no two ways about it . . . controls for motor and transformer overheat protection, electric circuit overload protection, or temperature controls for radio equipment *must* operate accurately every time for efficient protection.

Klixon Snap-Acting Controls provide sure, accurate operation under all conditions. The secret of Klixon dependability lies in the Spencer snap-acting thermostatic disc. This foolproof actuating element snaps "on" and "off", always making a quick, clean break or a solid make. Its accurate performance is unaffected by shock, vibration, motion, altitude or the mounting position. And because it contains no fussy parts, such as relays, toggles, magnets, there is nothing to get out of order.

Small, compact and light weight, Klixon Snap-Acting Controls are available in many standard models, such as those illustrated, for most control requirements. Write for complete information.

KLIXON

SPENCER THERMOSTAT COMPANY, ATTLEBORO, MASS.

See It?

JELLIFF ALLOY "C"

Resistance Wire

. . . . so tiny it's practically invisible to the naked eye (.0008)! Yet, consistent uniformity is attained. Every wire is drawn in our own plant; every spool receives micrometric inspection. Jelliff Alloy "C" resistance wire is truly dependable, dependability maintained always by the care and constant supervision of Jelliff engineers throughout every operation.

WIRE PRODUCTS Jelliff SINCE 1880

SPECIALISTS IN FINE WIRES

C. O. JELLIFF MFG. CO.

SOUTHPORT, CONN.

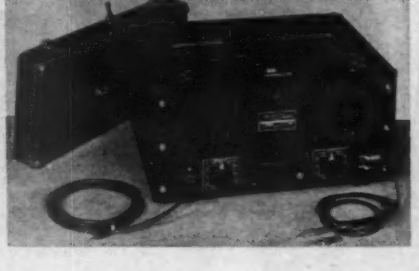
recordings are easily handled, and cost is only 3 to 10 cents per 100 square inches depending upon the form of paper used and the quantity ordered.

Other papers also available include hard white-surfaced paper for sooted or smoked recordings, waxed surface paper in which compression of wax by the stylus permits the contrasting blue, black or red background to show through, ammonia papers that can be developed dry merely in the presence of ammonia vapors, regular blueprint papers, and regular photographic papers requiring wet developing.

Gorrell & Gorrell, 40 Littlefield Road, Newton Centre, Mass.

Multi-Frequency Generator

MODEL ATF-1336-2 PORTABLE multi-frequency generator ("Watch Master") produces eleven different frequencies between 10 and 190 cps. All of the frequencies are derived from a single temperature-compensated and pressure-controlled tuning fork and therefore have the same accuracy as the tuning fork,



Output voltage of the instrument is rated 30 volts minimum for any frequency. The output impedance is rated 500,000 ohms, maximum. Power supply is 100–125 volts, 50–60 cps. Power consumption is rated 40 watts, maximum.

American Time Products, Inc., 580 Fifth Ave., New York, N. Y.

Improved Test Chamber

IMPROVEMENTS OF MODEL RTC-1 test chamber for high and low temperatures include four individually operated plugs in the panel of the door to permit ready access to the interior of the testing chamber to either adjust the position of the part being tested or to change the reading of a regulated instrument without removing it from the

NOT STICKY

this new Moisture Proofing service

POLISHES WAXED PARTS TO A DUST-FREE HARD FINISH . . .

service includes . .

✔ DEHYDRATING
Small parts are thoroughly dehydrated for the length of time needed to thoroughly extract moisture.

✔ AUTOMATIC DIPPING
Parts are waxed and varnished according to specifications and all areas are thoroughly coated.

✔ IMPREGNATING
Sufficient time is allowed to thoroughly impregnate all materials to the full extent of their procity.

✔ CENTRIFUGING
All surplus wax is removed by this operation leaving all machined surfaces and counter bores clean and smooth.

✔ POLISHING
All smooth surfaces are polished to a dust-free hard finish.

Daily PICK-UP AND DELIVERY in METROPOLITAN AREA

PRODUCTION ENGINEERING CORP.

660 VAN HOUTEN AVE.

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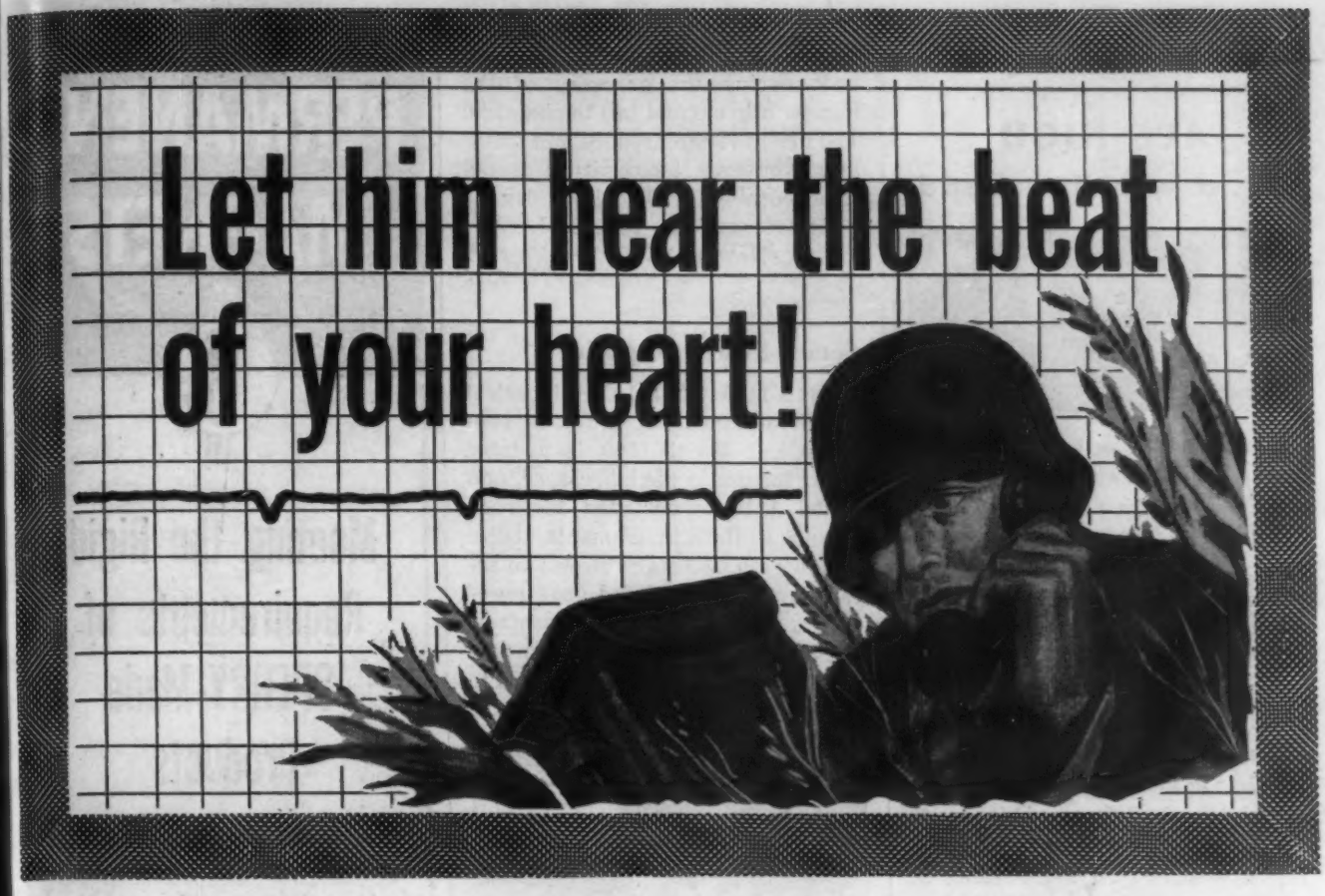


Over the whining bullets and the bursting shells . . . and in the dark silence of the night . . . he wants to hear the beat of your heart.

High up in his jungle roost, or down in the mud on his belly . . . waiting, watching, listening . . . he wants to know whether you're doing the things that will make his job easier, and the war shorter.

And if he were right here beside you, he might want to ask a few personal questions . . . like these:

Did you put some of this week's pay in war bonds?

Are you saving the scrap and fats and paper and other things we need to fight this war?

Have you given blood to the Red Cross to save the boys who are fighting to save you?

And . . . did you do your job today as if the outcome of the war depended on you alone?

These are the ways to show you're backing him up. These are the ways to let him hear the beat of your heart.

★ ★ ★

Here, at Kenyon, we're mighty proud to be playing a small part in winning a big war. That is why every Kenyon transformer used by the U.S. Signal Corps and other military branches reflects the same high craftsmanship and precision that went into our peacetime production. To bring victory closer, Kenyon workers are determined to do their share by turning out good transformers as fast as they know how.

THE MARK OF EXCELLENCE

KENYON TRANSFORMER CO., Inc. 840 BARRY STREET NEW YORK, U. S. A.

PRECISION PARTS

ACE HIGH
. . . a winning hand

Radios are almost as important to wartime flying as the wings or the motor of the ship itself. These little brass condenser-plates for aircraft radios will help bring many a flyer back from his mission.

Ace turns them out by the hundreds of thousands. There must be no burring and the similar contours of both pieces must be identical. They are tested by projecting their image, 50 times enlarged, on a screen.

Here at Ace you will find the finest machines in the industry, and the managerial know-how for producing parts twice as fine, ten times as fast, as ever before. Whether you are thinking in terms of current production or planning for post-war, it will pay you to see Ace for small parts or assemblies that call for stamping, machining, heat-treating, or grinding. Send us a sample, sketch, or blueprint for quotations.

The complete story on Ace facilities and capabilities. Send for a copy.

ACE
TRADE MARK

ACE MANUFACTURING CORPORATION
for Precision Parts

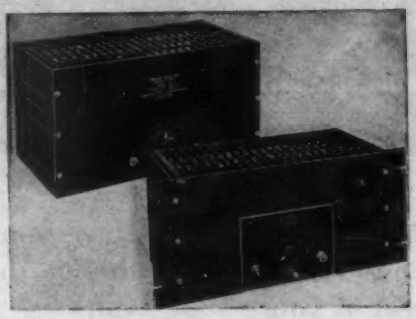
1255 E. ERIE AVE., PHILADELPHIA 24, PA.

chamber. This eliminates the necessity for opening the whole door and endangering the accuracy of the test on other parts in the chamber. The machine can produce and maintain whatever temperature is desired between −70 to 158.8 deg. C.

American Coils, Inc., 25 Lexington St., Newark, N. J.

Series Power Supplies

MODELS 1100 AND 1110 are identical in performance but differ in construction. Model 1100 is a table model for use in the laboratory, and Model 1110 is designed for rack mounting. Both instruments utilize a high gain two stage circuit to insure low noise level and good regulation. A potientiometer controls the high voltage output which can be shifted through a range of 225 to



300 volts. The change in voltage output from no load to full load is less than 1 volt. The primary of the power transformer is tapped for use at 105, 115 and 125 volts on 50–60 cps. Furnished with the instrument is an unregulated heater supply winding of 6.3 volts at 5 amps.

Communication Measurements Laboratory, 116 Greenwich St., New York, N. Y.

50 Amp Aircraft Relay

SOLENOID TYPE, 50 amp, aircraft relay will withstand a surge load of 400 amps without injury to the contacts (leads are fully protected). Vibration resistance is rated 5 to 55 cps with a total excursion of ¼ inch in any direction. The unit weighs 0.6 lbs approximately and may be used in applications other than aircraft.

The Hart Mfg. Co., Hamilton St., Hartford, Conn.

PERMANENT MAGNETS

Meeting the Rigid Requirements of SPERRY-Made Products

When lives and equipment depend upon precision instruments, "satisfactory performance" is not good enough for The Sperry Gyroscope Company. Perfection is demanded . . . and, in Cinaudagraph Permanent Magnets, perfection is obtained. We are meeting every rigid specification and a heavy production schedule—the reason, perhaps, why we are one of the larger suppliers of permanent magnets for Sperry.

Our extensive experience and manufacturing facilities can also help you solve your magnet problem.

ARMY (E) NAVY

4-CC-3

CINAUDAGRAPH CORPORATION

STAMFORD, CONNECTICUT

Mister! These Could Be Your Hands . .

Right at your own desk, alone and in your own way, you can appraise the value of this modern CLUTCH HEAD Screw in terms of speed, safety, and low cost on the assembly lines.

With the assortment of CLUTCH HEAD Screws and sample Center Pivot Type "A" Bit . . . *mailed to you* on request . . . you can check the fact that CLUTCH HEAD has everything offered by any other screw, *plus* definite features found in no other screw on the market today. In a word, we are content to let you discover that CLUTCH HEAD is a screw that sells itself, on sight, and by any basis of comparison.

On the score of dependable production, you may place reliance on the resources of this organization and on those of responsible Licensees.

For field maintenance and repair, it is important to note that this is the only modern screw operative with the ordinary type screwdriver . . . even with a piece of flattened steel rod in emergency. This feature has proved its value in many phases of the war effort.

CLUTCH HEAD · SCREWS ·

Consider the economy of time and money in this Center Pivot Type "A" Bit. It serves through a longer continuous "spell." Full reconditioning is merely a matter of a brief application of the end surface to a grinding wheel.

UNITED SCREW AND BOLT CORPORATION

CHICAGO CLEVELAND NEW YORK

FROM THE WHALE'S BELLY— 1944 VERSION

In everything of Uncle Sam's that "flies, floats or shoots," National Vulcanized Fibre and Phenolite, laminated Bakelite, are playing a vital part. This is because of their lightness in weight, dielectric strength, ready machineablility, exceptional wearing and other qualities.

YANKS in Tanks, guns ablaze spewing forth in face of fire on enemy beachheads . . . that's the 1944 war saga of the sea.

The role of the LST (Landing Ship Tank) the modern whale, is to put men, equipment and supplies on the beach in the right order for successful invasion. The right order in which the LSTs, the tanks, and a great amount of our fighting equipment operate in turn, is dependent upon thousands of parts made of plastics, like National Vulcanized Fibre and Phenolite, laminated Bakelite.

We salute America's designing engineers who have developed our highly effective landing craft.

NATIONAL VULCANIZED FIBRE CO.

WILMINGTON DELAWARE

Offices in Principal Cities

The LEADER in Telegraph Tapes

TELEGRAPH Tapes by the Paper Manufacturers Company have played an increasingly important part in the service of communications.

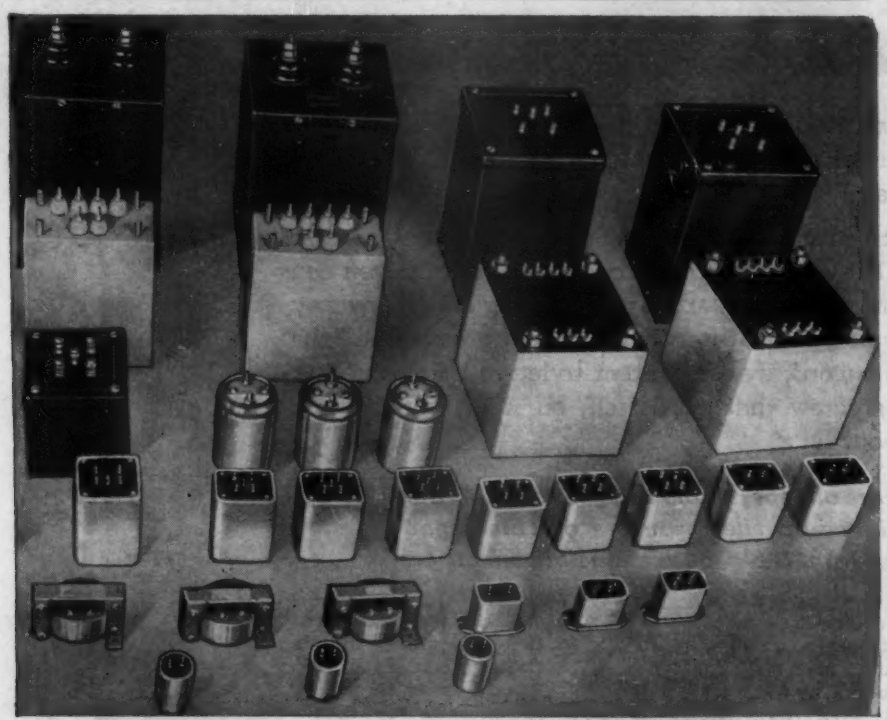
They've enjoyed continual preference for two very good reasons (1) their quality is consistently uniform (thanks to rigid laboratory control) (2) they have kept pace with each new development in the communications field.

We are proud of the fact that these, and other Paper Manufacturers Company products, have been selected to serve in so many phases of the national war effort.

Under the brand name PERFECTION, Paper Manufacturers Company produces a complete line of Teletype, Perforator and Ticker Tapes, Morsegraph Tapes, Teletypewriter Rolls and Recorder Tapes for all machines. In performance and quality, they offer convincing proof that "PERFECTION" *DESERVES* PREFERENCE.

Paper Manufacturers Company • Philadelphia 23, Pa.

THE WORLD'S PREFERRED SOURCE FOR COMMUNICATION ROLLS



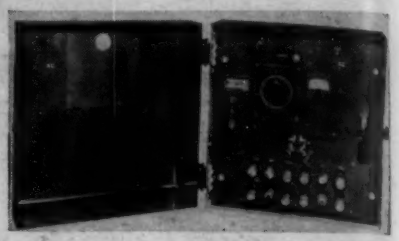
Performance Engineered Electronic Transformers

THE ACME ELECTRIC & MANUFACTURING CO. • CUBA, N.Y. • CLYDE, N.Y.

Acme ACME Electric

Current-Regulated Compensator

A NEW CURRENT-REGULATED compensator for resistance welding machines is specifically designed to facilitate consistent welds by holding the rms, or true heating value, of the weld current constant for any heat-control setting, without requiring continual manual adjustment. The compensator consists of

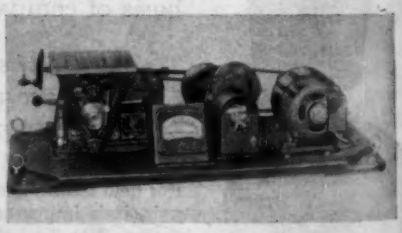


an electronic control circuit which automatically retards or advances the firing point of the ignitron tubes used to control the welding current. The compensator can be readily mounted on or near the welding machine. It can be applied to resistance welding controls which incorporate the phase-shift method of heat control.

Electronic Control Section, General Electric Company, Schenectady, N. Y.

Vibration Fatigue Tester

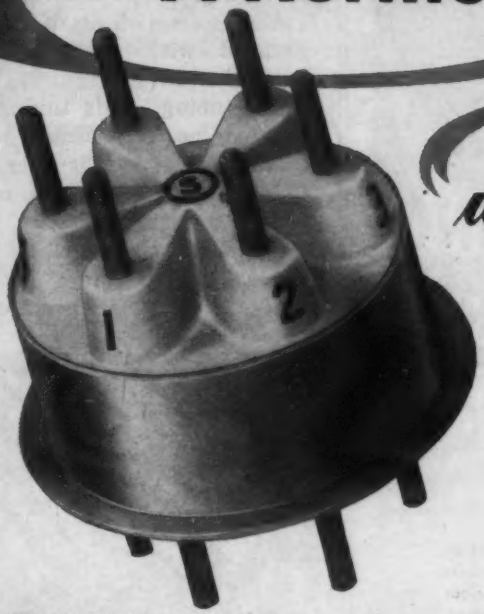
THIS TESTER IS AN addition to the manufacturer's line of testing machines. It is designated as Model 10V and features automatic cycling. It has a table area of 8 x 8 inches and has drilled and tapped holes for attaching work which is to undergo the test. It tests small electronic, electrical and mechanical parts and can handle parts or assemblies up



to 10 lbs in weight. Vibration, in simple harmonic motion, is produced vertically. Acceleration is controlled automatically by a device which changes the frequency from 10 cps to 55 cps (600 to 3,000 vibrations per minute) and back to 10 cps continuously and uniformly, the complete cycle re-

A Hermetic Seal *with* KOVAR

TRADE MARK 337962, REGISTERED IN U. S. PATENT OFFICE



HERMETIC seals of Kovar and glass are made in a wide size range and with single or multiple electrodes. Electrodes may be solid or tubular.

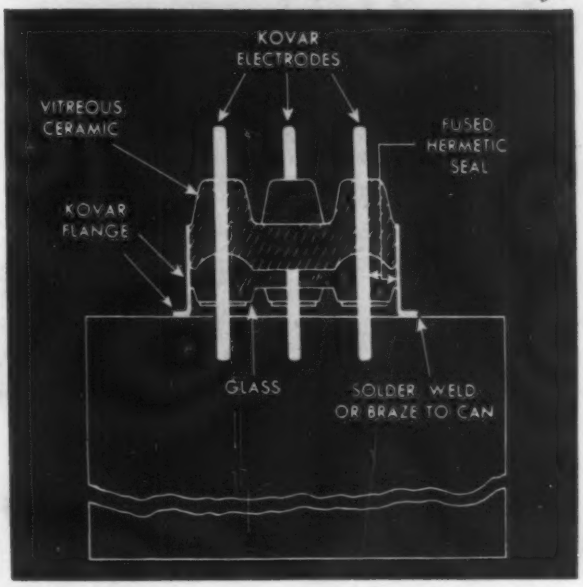
The design illustrated uses a vitreous glazed ceramic top, clean in appearance and numbered to identify each electrode. The Kovar electrodes are located in the ceramic and hard glass preform. This assembly is then sealed to the Kovar parts by fusing the hard glass.

The seal between Kovar and glass is a chemical bond in which the oxide of Kovar is dissolved into the glass during a heating process. The result, a hermetic seal—permanently vacuum and pressure tight, effective under the most extreme climatic conditions—tropical to stratosphere.

Kovar IS the answer to permanent vacuum or pressure tight sealing. Let Stupakoff help engineer YOUR hermetic sealing problems with Kovar.

. . . its elements

and its application



Use KOVAR for sealing

ELECTRONIC TUBES	SWITCHES
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TRANSMITTERS

ARMY E NAVY
"FOR GREAT ACHIEVEMENT"

Let's All Back The Attack — BUY WAR BONDS

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Products for the World of Electronics

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KEY TO

Laboratory Standards

Standard Signal Generators
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•
U. H. F. Noisemeters
•
Pulse Generators
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Moisture Meters
•

MEASUREMENTS CORPORATION
BOONTON, NEW JERSEY

quiring one minute. Acceleration can also be adjusted manually from 10 cps to 60 cps. Frequencies are accurately recorded on a sensitive electric tachometer. Maximum capacity is approximately 37 g. The unit is powered by ½ hp, 110 volt, 60 cps a-c split-phase motor.

The tester is described completely in Bulletin 210 available from All American Tool & Mfg. Co., 1014 Fullerton Ave., Chicago 14, Ill.

Electromagnetic Chuck and Power Unit

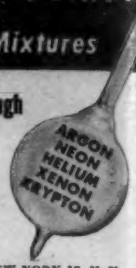
THESE "DO ALL" MAGNETIC CHUCKS are designed expressly for precision work. They provide high holding power. They are made of steel and are waterproof. The coils are wound with a type of plastic covered magnet wire and are sealed to prevent damage from moisture or breakdown from electrical or mechanical sources. The input wire is located on the right end of the chuck to eliminate interference in grinding and cleaning operations and wear on the cord. No auxiliary clamps are necessary since the chucks can be mounted directly to the table.

The varying power unit is an electronic device and is known as "Do All" Selectron. It gives the operator control over the magnetic pull from the chuck and also demagnetizes the chuck. The variable magnetic pull makes possible the grinding of difficult jobs such as flat warped pieces. The unit eliminates the need of a generator or rectifier since it produces the d-c current with which to operate the chuck. Work may be removed from the chuck without scratching either the work or the chuck and an operator can take the warp out of thin parts in very little time. It is rated at 175 watts maximum with an input rating of 220 or 440 volts 60 cps a.c. Output rating is 220 volts d.c. Angle brackets are provided for mounting on any make surface grinder.

Chuck Models 618 and 824 and the Selectron are illustrated and described in a bulletin available from Continental Machines, Inc., 1301 Washington Ave., S., Minneapolis 4, Minn.

AIRCO TESTED PURITY
Rare Gases and Mixtures

Distributed Nationwide through
AIRCO offices



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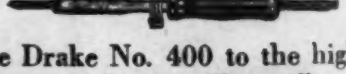
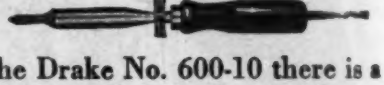
AIR REDUCTION
General Office: 60 E. 42d St., New York 17, N. Y.

THERE'S A DRAKE SOLDERING IRON FOR EVERY TYPE OF ELECTRONIC WORK

From that mighty mite



the Drake No. 400 to the high-speed production "honey"



the Drake No. 600-10 there is a high quality Drake Soldering Iron "just right" for the job.

•

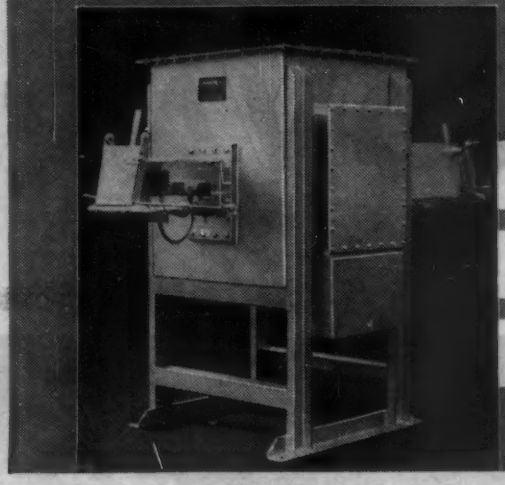
Drake Heat Controls and the Drake "Magic Cup" Stand are important soldering aids.

SEE YOUR RADIO PARTS JOBBER

DRAKE ELECTRIC WORKS, INC.
3656 LINCOLN AVE. CHICAGO, ILL.

Harper

HIGH TEMPERATURE



Electric Furnaces for

SINTERING POWDERED METALS

Temperatures up to 2750°F. Gastight construction for atmosphere control. Photograph shows entrance, high temperature and water cooled chambers with flame curtain at entrance and exit for continuous operation. Various sizes for research and mass production. Used by America's foremost concerns. Write for engineering data.

HARPER ELECTRIC FURNACE CORP.

Write to 1463 BUFFALO AVENUE, NIAGARA FALLS, N. Y. Representatives In Principal Cities

Pyra-Shell

Reg. U.S. Pat. Off.

TRANSPARENT UTILITY BOXES

For Stock Room Use

Important tools and vital small parts can be kept sorted and ready for immediate selection in these patented Pyra-Shell transparent utility boxes. The contents are protected against damage or loss and can be located instantly by looking through the box.

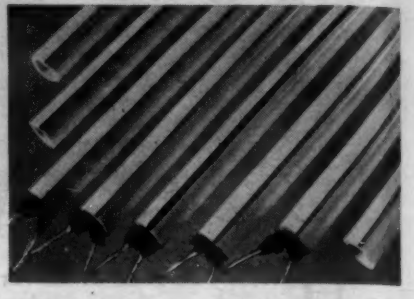
If one of the many standard styles and compartment arrangements will not meet your needs, we can design a special box for your particular use.

Write for a free illustrated folder.

SHOE FORM CO. Inc. *Utility Box Dept.* R **AUBURN, N. Y.**

Tubing with Colored Identification Stripes

TO PROVIDE INSULATION for electrical wiring, and to facilitate identification, Lumarith plastic tubing is extruded with contrasting color identification lines right in the body of the tubing. This tubing is designated as "Striatube" and is available in opaque or transparent tubing, in either flexible or rigid form in a variety of sizes, lengths and thicknesses, as well as various degrees of flexibility. In all instances the color stripes are an integral part of the extrusion and are as permanent as the body of the tubing itself. Striatube has high dielectric strength and non-oxydizing properties and is highly resistant to acids, alkalis, oils and greases, nor will it deteriorate due to aging or constant exposure to light.



Lumarith is a product of the Celanese Celluloid Corp., 180 Madison Ave., New York, N. Y., and Striatube is a product of Carter Products Corp., 6921 Carnegie Ave., Cleveland, Ohio.

Insulating Varnishes

AIR-DRYING, insulating varnishes, designed for use in the manufacture and repair of electrical equipment are called "Speedairbonds." The varnishes dry fast to a smooth, glossy finish. They are oil-proof and water, acid and alkali resistant and possess high dielectric qualities. They are designed to give complete protection and insulation under adverse circumstances and atmospheric conditions. The varnishes may be applied by brushing, dipping or spraying. The several types of varnishes are described in Bulletin 243.

The Sterling Varnish Co., 181 Ohio River Blvd., Haysville, Pa.

RCP SUPERTESTER

MODEL 422

This test instrument is equivalent to 27 individual instruments in one compact unit – with very low and very high ranges. Excellent for general circuit testing – speeds up trouble shooting – and combines many important measurements in one small case. Features are: Current measurements in both A.C. and D.C. up to 25 amperes. Voltage measurements in both A.C. and D.C. up to 5,000 volts. D.C. sensitivity 5,000 ohms per volt. Resistance measurements up to 10 megohms.

Code – MERAY . . .

Complete with batteries..... $29.50

POCKET MULTITESTER

MODEL 420

"Pocket" size yet rugged with good accuracy comparable to larger RCP models – Model 420 – only 6⅜" x 3½" x 3" – open face – weighs only 25 ounces – meter movement accurate within 2%. Voltage and multipliers accurate to 1%. A.C. and D.C. voltmeter up to 5,000 volts at 1,000 ohms per volt sensitivity. D.B. meter, output meter, milliammeter and ohmmeter. Total 23 ranges.

Code – LIYOR . . .

Complete with batteries, ready to operate..... $19.95

Complete details of these two testers and other RCP radio, electrical and electronic testing instruments are contained in the *NEW* RCP Catalog No. 128 of standard commercial models. Write today for your copy. Our engineers will welcome the opportunity to cooperate with you on production testing problems.

REASONABLE DELIVERIES ARE NOW BEING SCHEDULED

RADIO CITY PRODUCTS COMPANY, INC.

127 WEST 26th STREET — NEW YORK CITY 1, N. Y.

MANUFACTURERS OF PRECISION ELECTRONIC LIMIT BRIDGES – VACUUM TUBE VOLTMETERS – VOLT-OHM-MILLIAMMETERS – SIGNAL GENERATORS – ANALYZER UNITS – TUBE TESTERS – MULTI-TESTERS – OSCILLOSCOPES – AND SPECIAL INSTRUMENTS BUILT TO SPECIFICATIONS

Quality TOOLS for
Quality WORKMANSHIP
XCELITE
Screwdrivers
Nut Drivers
The original screwdrivers with the tough, transparent XceLite shockproof plastic handles. Blades of high quality steel, accurately machined. Unsurpassed tools for electrical and general use. Over 50 sizes and styles, square and round blades. Many sizes available with special fire-resistant handles at slightly higher prices.
Ideal tools for electrical work, especially panel jobs. Extra deep sockets, precision machined, handles two nuts. Handles are genuine shockproof, fire-resistant XceLite. Supplied in 6" and 9" lengths; 9 sizes from 3/16" to 5/8" nut size.
XceLite Screwdrivers and Nut Drivers are available on satisfactory priority ratings.
For details and prices on XceLite Tools, ask your regular dealer—or write Dept. C.
Park Metalware Co., Inc., Orchard Park, N. Y.
BACK THE ATTACK.
BUY MORE WAR BONDS
XCELITE
QUALITY TOOLS
PREFERRED BY THE EXPERTS

TYPE AR 300A

(Manufactured to Army-Navy Specification JAN-212E).

Medium power triode for use as audio-frequency amplifier or modulator and radio-frequency oscillator or amplifier at medium frequencies.

A-F Power Amplifier and Modulator—Class B

D-C Plate Voltage	2000 volts
D-C Grid Voltage	-105 volts
Zero-signal D-C Plate Current per tube	40 ma.
Max.-signal D-C Plate Current per tube	300 ma.
Load resistance plate-to-plate	8000 ohms
Power Output (2 tubes)	650 watts

Plate-Modulated R-F Power Amplifier—Class C Telephony

D-C Plate Voltage	1500 volts
D-C Plate Current	300 ma.
D-C Grid Voltage	-200 volts
D-C Grid Current	75 ma. max.
Carrier output for mod. factor of 1.0	300 watts

Makers of high-quality Transmitting and Receiving Tubes since 1926.

IN-2-44

ROGERS
ROGERS RADIO TUBES LIMITED
TORONTO · CANADA

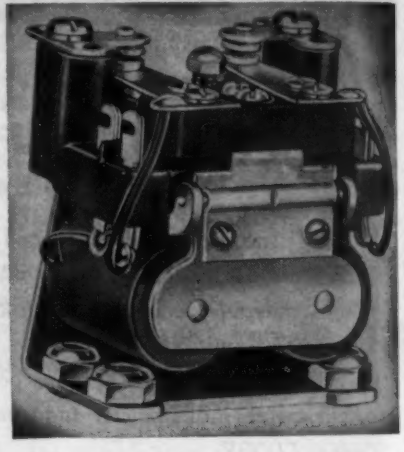
Bakelite Plug

DESIGNED PRIMARILY FOR use with the manufacturer's No. 37222 captive head posts and No. 37202 plates is a compact plug (No. 37212) which is available in black or red regular bakelite, as well as low-loss brown mica-filled bakelite, for r-f uses. There is a small circular depression on top of the plug for use in color coding or polarity indication.

James Millen Mfg. Co., Inc., Malden, Mass.

Dual Coil Relay

MODEL BOY IS A small dual coil power relay suitable for use in plate circuit applications where the limited amount of current is insufficient to operate a single coil power relay directly. The two coils of this new model may be connected in series for operation at one voltage and in parallel for a second voltage; or one coil can be used for operation

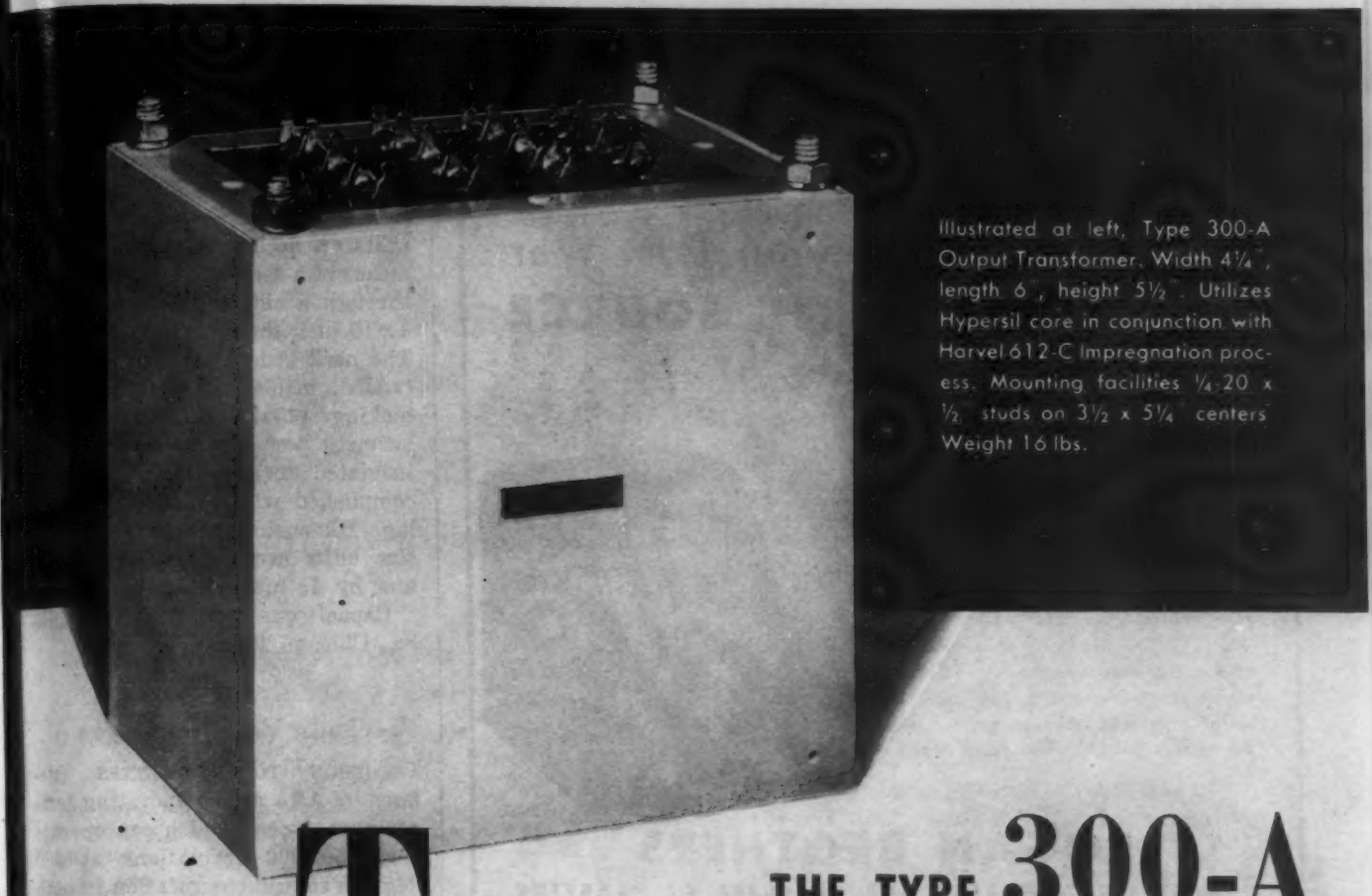


while the other is used for holding. The relay features semi-balanced armature construction and is ruggedly built to withstand 10 G. The coils are cellulose acetate sealed; will withstand salt-spray and high humidity. The relay meets Army, Navy and CAA Specifications. Dimensions are $1\frac{5}{8} \times 1\frac{7}{8} \times 1\frac{1}{2}$ inches, and the weight is 5 ounces.

Allied Control Co., Inc., 2 East End Ave., New York 21, N. Y.

Capacitor Unit

OIL TYPE CAPACITORS, designated as "EC" Capacitrons, are designed as standard components to replace similar types of special capacitors



Illustrated at left, Type 300-A Output Transformer. Width 4¼", length 6", height 5½". Utilizes Hypersil core in conjunction with Harvel 612-C Impregnation process. Mounting facilities ¼-20 x ½ studs on 3½ x 5¼ centers. Weight 16 lbs.

THE TYPE 300-A TRANSFORMER

The Type 300-A Output Transformer was engineered primarily as a part of the Langevin Type 101-A Amplifier. Designed to work out of four 6L6's parallel push-pull or equivalent with nominal secondary impedance values of 2/18/32/150/600 ohms. When used in a circuit employing feedback secondary terminations from 1 to 1000 ohms are available. Will safely handle 50 watts. Designed for wide frequency response, high efficiency (in excess of 90% at all nominal output impedances) and good wave form even at low frequencies at high output levels.

Besides manufacturing public address equipment and electronic devices, The Langevin Company, Inc., also manufactures transformers and reactors to exact requirements. Capacity up to 5 KVA. Hermetically sealed components to strict Army-Navy specifications.

The Langevin Company

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★ If your post-war products will require plastic parts in their construction, we suggest that you establish a source of production today to avoid the expected rush for plastics tomorrow.

Every day more manufacturers can see what their plastic requirements are to be and, consequently, they plan constructively for the post-war period and the great demand for plastic production that will come with it. We urge you therefore, to consult with our engineering department now. Get cost-free advice from seasoned plastic experts. Your action now will help get your products on the market quickly when peace comes.

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COMPRESSION MOLDERS AND BRANDERS OF PLASTICS

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PERMOPIVOTS

GIVE PROTECTION FROM WEAR AND CORROSION WHERE IT COUNTS

WITHOUT THIS PROTECTION . . .

The photographs reproduced above and to the left were taken after accelerated tests made under impartial supervision. The PERMOPIVOT (above) shows no signs of wear while the ordinary steel pivot (left) shows serious damage.

Every PERMOPIVOT* is tipped with Permometal* . . . a special precious-metals alloy developed and manufactured in Permo's own metallurgical laboratories. Permometal's extremely low coefficient of friction, its satin-smooth polish, and its resistance to corrosion and abrasion make it ideal for tipping pivots. PERMOPIVOTS eliminate the need of oil . . . keep precision instruments accurate longer . . . even under the most gruelling punishment.

PERMO, Incorporated

MANUFACTURING METALLURGISTS

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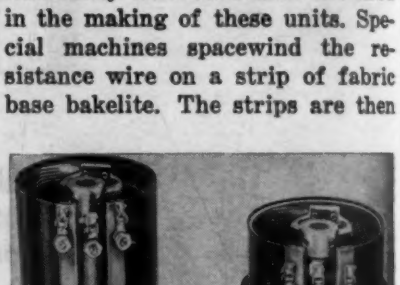
used in the production of war equipment. They are being manufactured in several ranges with d-c working voltage ratings from 600 to 1,500 to meet U. S. Signal Corps and Navy Specifications. The units are locked on the chassis by means of a solid nut and lockwasher through a single hole to clear the ¾ x 16 inch threaded Bakelite neck. The neck is lock-spun into the extruded, insulated metal container, making possible a 100 percent hermetic seal. Grounding of either insulated terminal is readily accomplished with a special ground-lug. Dimensions of the 3 and 4 μf size units are 1¾ inches in diameter by 4¼ inches in height.

Capacitrons Inc., 318 W. Schiller St., Chicago 10, Ill.

Precision Potentiometers

PRECISION POTENTIOMETERS (defined by ASA as low operating temperature types) which can operate for 2,500,000 revolutions at 360 degrees continuous rotation in both directions, for 24 hours a day are available in Types 260, 260T, 261, 275, 276, 281, 291, 292, and 296. Extremely close tolerances are used in the making of these units. Special machines spacewind the resistance wire on a strip of fabric base bakelite. The strips are then



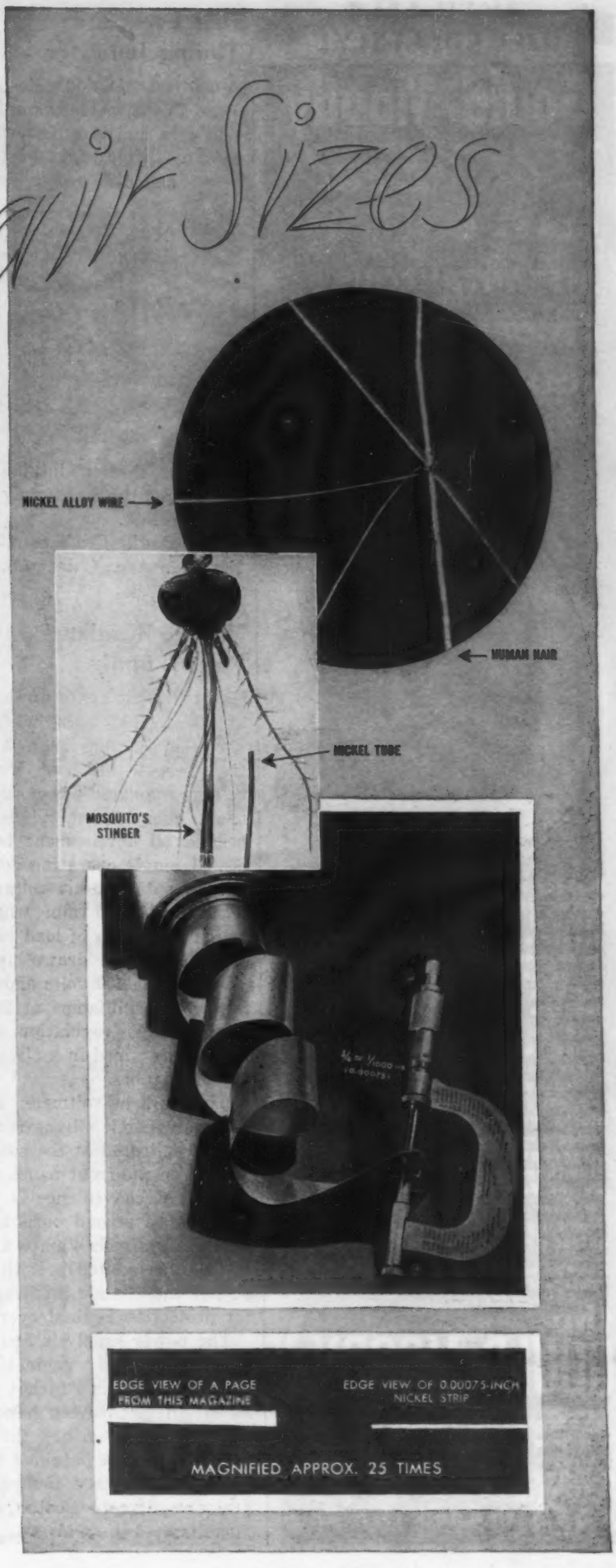
coated with a bonding agent which bonds the wire to the strip. A protective bakelite band is placed externally over the wire strip, securing the wire against mechanical damage or derangement. It is then bent around and fastened to the bakelite supporting form. Constant contact resistance and low noise level are maintained for any position of the knob through the use of separate wiping fingers. Types 261, 276, 281, 291, 292 and 296 have top wipers which are provided for the highest accuracy and for the closet tolerances.

De Jur-Amsco Corp., Shelton, Conn.

They wanted wire, tube and sheet in

Split-Hair Sizes

...and found the strong, corrosion-resistant metals they sought among the INCO Nickel Alloys



Are you looking for metals in ultra-fine sizes for essential applications today...or for your new products after the war?

Do you want...in addition to the split-hair size ...metals with strength, toughness and high resistance to corrosion?

Then take a look at these examples of how INCO Nickel Alloys can be produced in practically any form or size you may want for applications that need a rustless corrosion-resisting material with high mechanical properties...

THE WIRE shown in the magnified photo above knotted around two strands of human hair is 0.0009" thick. A pound would stretch 80 miles. It is a regular commercial product of the Driver-Harris Co.

THE TUBING, smallest ever drawn, is compared with a mosquito's stinger. Outside diameter of this nickel tube is 0.0019"; inside diameter, 0.0004". Superior Tube Company produces commercial tubing in INCO Nickel Alloys as small as 0.010", outside diameter.

THE STRIP is .00075" thick . . . one-third the thickness of this page. It would take more than 1300 strips to equal an inch. This nickel strip is made by Somers Brass Company for regular commercial use.

In addition to their group properties of high strength, toughness and corrosion resistance, individual INCO Nickel Alloys have *specialized* properties for applications requiring high-temperature strength, special hardness, resilience, etc.

"Tremendous Trifles" a booklet which discusses the properties, sizes and forms of 8 INCO Nickel Alloys will be sent to you on request. Please give Company, Name and Title. Address:

THE INTERNATIONAL NICKEL COMPANY INC.
67 Wall Street, New York 5, N. Y.

INCO NICKEL ALLOYS

MONEL • "K" MONEL • "S" MONEL • "R" MONEL
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Sheet... Strip... Rod... Tubing... Wire... Castings

"Landing According to Plan"

IN the planning . . . and the execution . . . of landing operations Communications are playing a vital part. That's why in the forefront of every landing party there usually is to be seen the man with the Pack Set strapped to his back. Light and compact, yet powerful and sturdy, this adaptation of the walkie-talkie provides the *instant communication* by which our intricate military operations are planned . . . and carried out.

In the Pack Set, as in many other audio communication instruments, Transformers by Rola are living up to a reputation gained through 25 years of leadership in Sound Reproduction. That, no doubt, is the reason why so many of the largest producers of communication equipment are looking to Rola for Transformers, Headsets, Coils and other Electronic Parts . . . why others are saying, "Let's discuss our problem with Rola".

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Let's do more ARMY E NAVY *in forty-four!*

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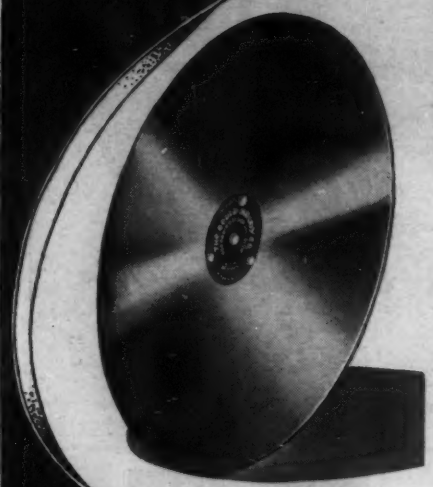

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Send us your priority rating, and we'll ship these famous, better-sounding, longer-wearing, more satisfying blanks immediately. Two weights — thin, flexible, interchangeable with aluminum, or medium weight. Four holes. Center-flow thread action. Won't age, harden, dry out or deteriorate.

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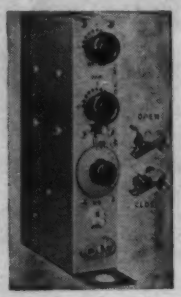
Dial Lock and Tuning Indicator

A TUNING-DIAL LOCK, designated as Type TU-52, performs a dual function of a dial lock that will accommodate a wide range of dial thicknesses and also a precision tuning



indicator that maintains a fixed position on the dial simply by snapping the lock.

The Radio Craftsman, 1341 S. Michigan Ave., Chicago 5, Ill.

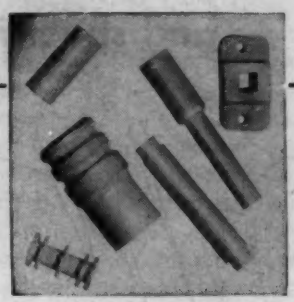
Voltage Regulated Power Supply

SUPPLYING D-C LOADS up to 40 watts at 200 to 400 volts, with voltage variation of less than 1 percent from zero to full load, Model 1218 voltage regulated power supply is a useful tool for general use in experimental development laboratories. A single operating control allows the d-c output voltage to be set at the desired value, where it remains regardless of load variation; current may be drawn up to 100 milliamps at 400 volts and increasing to 200 milliamps at 200 volts, with voltage regulation electronically maintained in a circuit using standard tubes.

The built-in voltmeter and milliameter permit direct reading of output delivered at the safety jack located on the front panel. Another feature of convenience is the provision of a second output jack at which is available 4 amps a.c. at 6.3 volts (unregulated). Both the d-c output and the a-c input are fused for protection against overload.

The power supply is housed in a ventilated steel cabinet, which measures 13 x 9 x 9 inches and has a convenient carrying handle. Bulletin J-1218 describes this equipment and may be obtained from the Technical Apparatus Company, 1171 Tremont Street, Boston, Massachusetts.

Lavite STEATITE CERAMIC



CHARACTERISTICS

Specific gravity of only 2.5 to 2.6
Water absorption 5. 1.5-0.001 per cent. Per cent power factor.
S. 1.5 to 60 cycles was only 0.0165.
Dielectric constant at 60 cycles was 5.9-1000 KC 5.4.

Makers of electrical and radio apparatus destined for war service are finding in LAVITE the precise qualities called for in their specifications . . . high compressive and dielectric strength, low moisture absorption and resistance to rot fumes, acids, and high heat. The exceedingly low loss-factor of LAVITE plus its excellent workability makes it ideal for all high frequency applications.

We will gladly supply samples for testing

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New Ideas ★ New Products
Relating to Chemical, Physical, and Engineering Laboratory Instruments, and Materials Testing Equipment
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BRING or send us your idea or new product even though partially or completely developed, indicating its scope of use, design features, advantages, and potential market. We will promptly and confidentially consider the possibilities of its development, manufacture and marketing.

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25 years of successful experience in the design and manufacture of scientific instruments; modern production facilities; experienced engineering and design staff; skilled craftsmen.
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8030 Georgia Avenue
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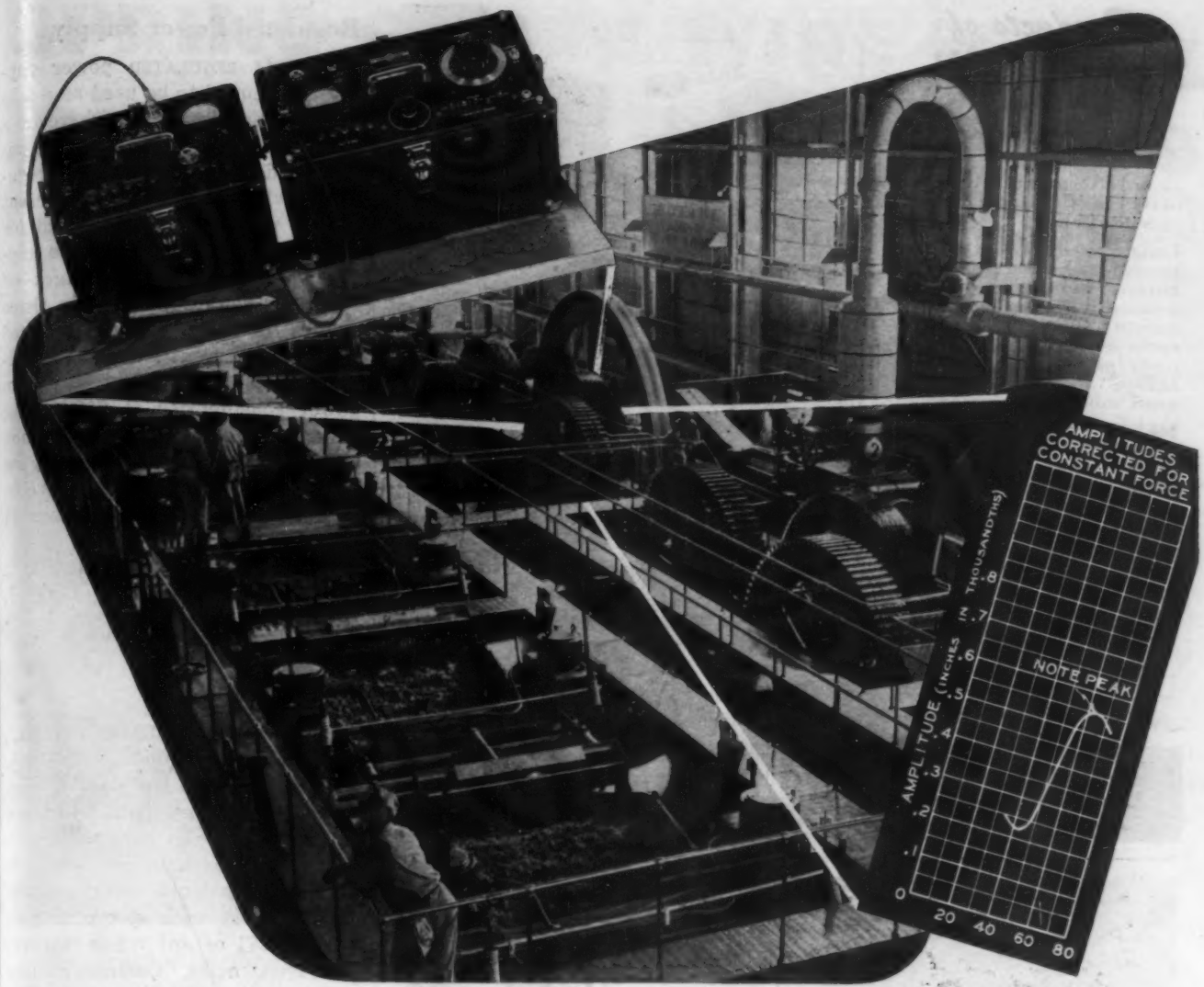


VIBRATION in this Heavy Engine Foundation

Located and Analyzed with General Radio Vibration Meters

VIBRATION in this sugar-cane grinding tandem in the Florida Everglades was sufficiently serious to cause uneven settling of the heavy concrete foundation. The magnitude of the vibration depended upon the speed of one of the three Corliss engines driving the tandem, increasing as the speed increased.

MEASUREMENTS with the General Radio Vibration Meter and Analyzer showed that the frequency of the main component of the vibration corresponded to the single-mesh frequency of the main pinion on the engine. A speed-vibration characteristic, taken over the complete range of operating speeds, showed a pronounced resonance peak at 68 rpm, near top speed. Calculations confirmed the fact that the concrete foundation was in resonance at the gear mesh frequency corresponding to this speed.

ELIMINATION of the vibration was simple, once its nature and source were completely known. The cause was found to be poor gear alignment, resulting in worn gear teeth.

Most vibration problems encountered in industry are simple — when you know the answer. General Radio noise and vibration-measuring instruments are designed to get that answer for you quickly and accurately. Their theory and operation are completely described in "THE NOISE PRIMER." Write for your copy today. **Ask for Bulletin No. 869.**

Because all of our facilities are devoted to war projects, this equipment is at present available only for war work.

ARMY E NAVY

GR GENERAL RADIO COMPANY Cambridge 39, Massachusetts
NEW YORK CHICAGO LOS ANGELES

We Are Pleased to Announce that

GENERAL ELECTRIC SUPPLY CORPORATION

has been appointed National Distributor for "Striatube" and "Pliatube" Tubing in order to make available to our customers the nation wide facilities and services of this well known electrical supply organization.

"STRIATUBE" and "PLIATUBE" TRANSPARENT TUBING

Of Vinyl base, these two transparent plastic tubings permit visual inspection of electrical conductors, guarding against installation of faulty wiring. At the same time in "Striatube", with its inlay extrusion of color stripes, the additional advantage of easy identification is provided. Either opaque or transparent tubing can be furnished with one or more contrasting color stripes.

Both "Striatube" and "Pliatube" have excellent insulating properties and are highly resistant to acids, alkalies, oils and greases. Available in formulations that remain flexible down as low as minus 60° F.

Write for Technical Data and Price List.

CARTER PRODUCTS CORPORATION

6924 Carnegie Ave. Cleveland 3, Ohio

"Less than 5° variation in a 24 hr. test of our Sta-Warm tank!"

HERE'S UNIFORM HEAT FOR COMPOUNDS USED IN HIGH SPEED PRODUCTION

If you heat wax, pitch, resins, chemicals . . . do you realize how much maintenance of correct, uniform temperature can help you hold production at high levels?

Under factory conditions, Sta-Warm heaters now in use are holding to temperatures within plus or minus two degrees. That's well inside of practical high speed working limits.

The reason Sta-Warm assures you of uniform heat required on many dipping or spraying operations is found in the electrical circuits which are wound completely around sides and bottom of each vessel. Sta-Warm makes heat available where it is needed. Accurate thermostat control does the rest, compensating for constant dipping of cold materials in the solution and compensating for fresh compound being added to replenish supply.

If you are open to a better solution of your compound heating problems, let Sta-Warm engineering service help you. No obligation. Write . . .

STA-WARM ELECTRIC CO.

1000 N. CHESTNUT ST. • RAVENNA, OHIO

Microhmmeter

TYPE G-710 MICROHMMETER is an improved a-c bridge for use in recording or controlling apparatus such as temperature, moisture and pressure control. It will measure from 0.001 ohm to 1 megohm. The readings are taken from a decade. A meter is used as a null indicator. On all ranges the instrument requires a few tenths of a milliwatt through the resistance being measured. Measuring voltage is 60 cps a.c. Pure resistance may be read directly in ohms. Impedances are measured by comparison and changes as low as 0.01 percent are indicated.

A bulletin (No. 432) is available from Tech Laboratories, 7 Lincoln St., Jersey City 7, N. J.

Lightweight Power Transmission Unit

A REMOTE CONTROL right angle adapter is designed to provide a connection for flexible shaft control where the space limitations do not permit a direct conjunction without bending the shaft in too small a radius. The unit is sturdy and light in weight (0.141 lbs) and may be used in applications where the power transmission must of necessity be at a small radius. The size of the adapter is 2 x 1⅛ x ⅞ inches. The gear ratio is 1 to 1. The maximum torque load is 25 inch pounds. The connections are ⅜ x 24NF3 threads.

F. W. Stewart Mfg. Corp., 4311 Ravenswood Ave., Chicago, Ill.

Beryllium Copper Wire

SILVER COATED BERYLLIUM copper wire is available in sizes 0.064 to 0.007 inches. It is trade-marked "Silvercote" and has a guaranteed minimum tensile strength of 185,000 pounds after hardening.

Little Falls Alloys, Inc., 189 Caldwell Ave., Paterson, N. J.

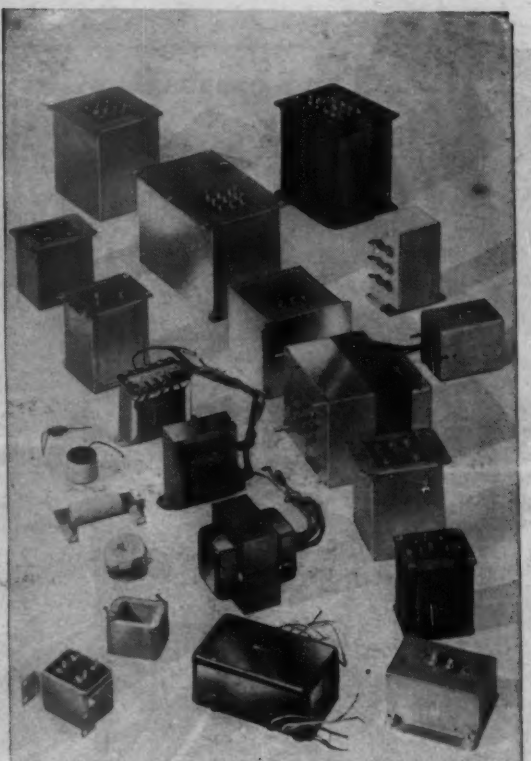
Products of
"MERIT"
means
Fine Radio Parts

. . . PARTS manufactured exactly to the most precise specifications.

Long manufacturers of component radio parts, MERIT entered the war program as a complete, co-ordinated manufacturing unit of skilled radio engineers, experienced precision workmen and skilled operators with the most modern equipment.

MERIT quickly established its ability to understand difficult requirements, quote intelligently and produce in quantity to the most exacting specifications.

Transformers—Coils—Reactors—Electrical Windings of All Types for the Radio and Radar Trade and other Electronic Applications.



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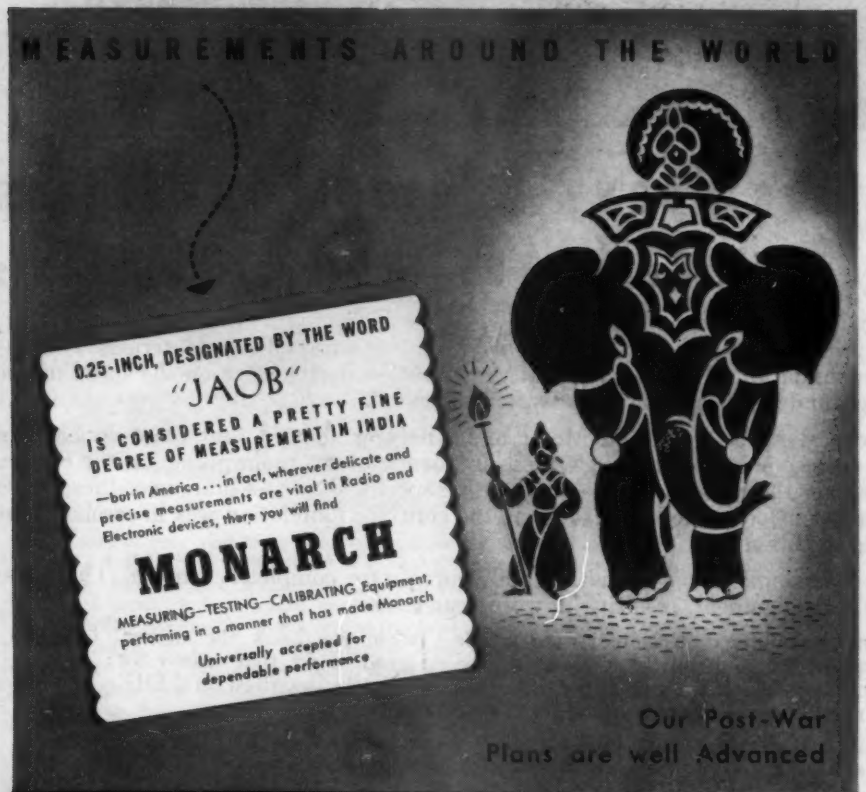

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"JAOB"
IS CONSIDERED A PRETTY FINE DEGREE OF MEASUREMENT IN INDIA
—but in America . . . in fact, wherever delicate and precise measurements are vital in Radio and Electronic devices, there you will find
MONARCH
MEASURING—TESTING—CALIBRATING Equipment, performing in a manner that has made Monarch
Universally accepted for dependable performance

Our Post-War Plans are well Advanced

MONARCH MFG. CO.
2014 N. Major Ave. Chicago, Ill.

Regulated Power Supply

MODEL 44 REGULATED power supply is intended to be used as a laboratory instrument, or wherever a source of voltage of a variable nature is desired. It has good regulation with change in load current or line voltage. It can be used for either bias, filament or plate supply voltage. Output voltages of from 300 volts down to 0 in three ranges may be obtained. Rated d-c output current is rated 100 milliamps on all ranges. Maximum power consumption is 200 watts; voltage controls are of single knob adjustment and range-changing switch; hum content is 12 millivolts, rms, maximum. The unit uses 11 tubes.

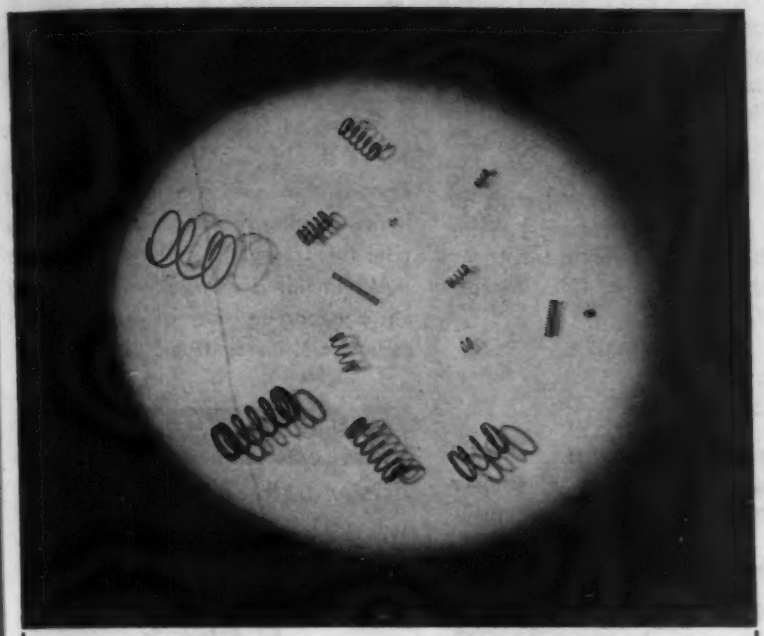
Radio-Television Institute, Inc., 480 Lexington Ave., New York 17, N. Y.

Aircraft Receiver

THIS COMPACT AIRCRAFT receiver, designated as Model AR-10-A, weighs 24 lbs and is designed to replace five or six receivers which are used in a plane as it is an all-purpose, all-frequency receiver. It has a beacon band coverage from 195 to 425 kc with spot tuning on 278 and 271 or any other two specific frequencies. Communications band coverage is from 2500 to 4500 kc and from 4500 to 8000 kc with pre-tuned circuits for twelve crystal controlled frequencies anywhere in the 2500 to 10,000 kc band. There are two r-f channels, one for frequencies from 4.5 to 10 Mc for the day channel and one for 2.5 to 4.5 Mc for night channel. Image attenuation is greater than 65 db. An input of two microvolts modulated 30 percent at 400 cycles produces an output of 50 milliwatts at a signal to noise ratio of 6 db.

Harvey-Wells Communications, Inc., Southbridge, Mass.

SPRING GRADE WIRE is Now the First Step in Micro-Processing



Meets higher specifications than established ASTM Standards

"Silvercote" Spring-Grade Wire used in Micro-processed Springs has these guaranteed properties: Guaranteed minimum tensile strength, 190,000 lbs. per sq. in. after hardening. High uniformity in temper. Accurately controlled conductivity.

Better Coil Springs at No Added Cost

Micro-processing essentially is a specialized production technique by which the inherent electrical and mechanical properties of beryllium copper are controlled to produce maximum performance in coil springs.

Years of laboratory research and design experience by Instrument Specialties Company has indicated that the ultimate in spring performance could not be reached until a beryllium copper wire of guaranteed "spring grade" were available. Now, an adequate supply of this premium quality beryllium copper wire is an accomplished fact as the data to the left signifies. Silvercote Spring-Grade beryllium copper wire is being used 100% by Instrument Specialties for coil springs of all types. As a result, Micro-processing can do even a better job than ever before — at no added cost to you.

By using this special wire with guaranteed premium spring qualities, it naturally follows that peak spring performance is achieved in the micro-processing.

Every Micro-Processed Coil Spring Benefits

Plain or "fancy" springs benefit by the addition of Spring-Grade Beryllium Copper wire to the other values of Micro-processing — higher safe working stresses, less loss of tension, higher proportional limit, maximum conductivity, higher safe operating temperature, lower electrical loss, freedom from set or drift, and closer tolerances.

It would pay you to evaluate Micro-processed beryllium copper springs for your own use. Instrument Specialties Company produces coil springs which out-perform in service because every step in their production is controlled — beginning with Spring-Grade wire.

I-S Brush Spring Data Sheet

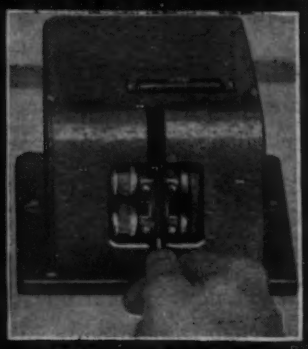
The quicker easier way to put Micro-processing to work — fill out the I-S Data Sheet and we'll do the rest. Write for data sheets today, or send your specifications and inquiries. Remember Micro-processed brush springs are easier to assemble, add life to brushes and give maximum performance in service.

INSTRUMENT SPECIALTIES CO., INC.

258 BERGEN BOULEVARD, LITTLE FALLS, NEW JERSEY

FIELD ENGINEERING OFFICES: BOSTON · CHICAGO · CLEVELAND · PHILADELPHIA · NEW YORK

"HOT OFF THE WIRE"
PRODUCTION STRIPPING



New IDEAL
"Hot-Blade"
WIRE STRIPPER

Quickly strips cotton, silk, or rubber from fine stranded or solid wires. Insulation is burned (not cut) from wire by two electrically heated blades. No cutting or nicking of wire.

IDEAL Electric
MARKING TOOLS

Permanently mark small parts and finished products. Prevent mistakes and errors. Used like a pencil. Makes 7200 strokes a minute. Available with diamond point for extra hard surfaces.

IDEAL ELECTRIC ETCHER

All purpose. Permanently marks all smooth surfaced steel, iron and their alloys. 4 etching heats.

Most complete line on the Market

DETAILS ON REQUEST

IDEAL Sycamore
IDEAL COMMUTATOR DRESSER CO.

1631 Park Ave. Sycamore, Ill.
Sales Offices in all Principal Cities
In Canada: IRVING SMITH, LTD., Montreal, Quebec

Industrial X-ray Film Illuminator

ACCORDING TO THE manufacturer, this new illuminator (for viewing industrial x-ray films) provides four times more illumination than previously available. It has a finger-tip adjustment which attains brightness for films of different density, or for different parts of the same film. The photoflood lamps of the machine are designed with a fan-type cooling system to avoid cracking, curling or damaging the film from heat. A foot-switch controls the lamps. Another feature is a spotlight which measures 3 inches in diameter. The glass front of the spot is water-cooled with the light from the lamp passing through four inches of water.

Kelley-Koett Mfg. Co., Covington, Ky.

Tube Voltmeter

VACCUM-TUBE VOLTMETER, Model VM-27E, features a high frequency probe which permits close connection to be made to the circuit under test at high frequencies. It is

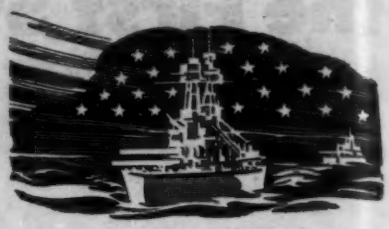
simple to operate. Voltages which can be measured range from 0.1 to 100 volts at d.c., and a-c and r-f frequencies to over 100 Mc.

Alfred W. Barber Labs., 34–02 Francis Lewis Blvd., Flushing, N. Y.

Portable Transformer

AN EMERGENCY, portable, 110-volt current source, 1 kva air-cooled unit (supplied for either 440-volt primary and arranged with dual fused secondaries of 110 volts each) is availabe from The Acme Electric & Mfg. Co., Cuba, N. Y.

PREMAX



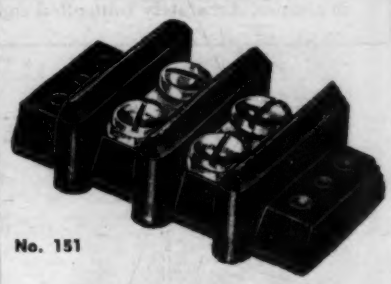
Premax Antennas
Go Into Battle

Where action is the hardest . . . where the PTs and the Fleets move in, Premax Antennas are doing their job in maintaining communications that are vital to Victory.

When this is over, Premax will have an outstanding line of antennas for commercial installations.

Premax Products
Division Chisholm-Ryder, Co., Inc.
4402 Highland Ave., Niagara Falls, N. Y.

JONES
BARRIER STRIPS
SOLVE MOST TERMINAL PROBLEMS



No. 151

A compact, sturdy terminal strip with Bakelite Barriers that provide maximum metal to metal spacing and prevent direct shorts from frayed wires at terminals.

6 SIZES

cover every requirement. From ¾" wide and 13/32" high with 5-40 screws to 2½" wide and 1⅛" high with ¼"-28 screws.

Jones Barrier Strips will improve as well as simplify your electrical interconnecting problems. Write today for catalog and prices.

HOWARD B. JONES
2460 West George Street
CHICAGO 18 ILLINOIS

Precision

QUALITY TUBING

For years we at Precision have been specialists in the small seamless tubing field, from ½" O.D. on down to 0.010" O.D. with whatever wall thickness is required, holding to unusual close tolerances. When accuracy and uniformity is the first consideration, we can help you.

We manufacture accurately drawn seamless aluminum, brass, copper and nickel tubing to exact specifications. We also fabricate and form nickel tubing electrode piece parts and various shapes of non-ferrous tubing.

PRECISION *for Accuracy*

Your inquiries for round tubing in all forms are solicited.

PRECISION TUBE CO.

SPECIALISTS IN ACCURATELY DRAWN TUBING AND METAL SHIELDED WIRE

Factory: 3824-26-28 TERRACE STREET • PHILADELPHIA, PA.

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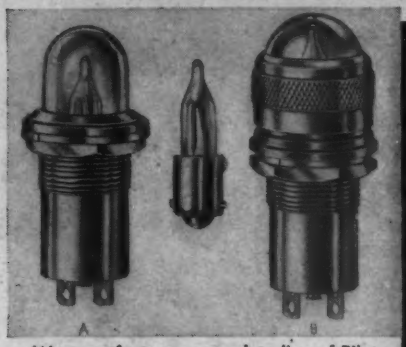
SALES DEPT. 215-05 27TH AVE. BAYSIDE, L. I., N. Y.

SIGNAL Offers
A NEW SERIES OF
NEON PILOT LIGHTS
(INCORPORATING G E. OR WESTINGHOUSE NEON LAMPS)



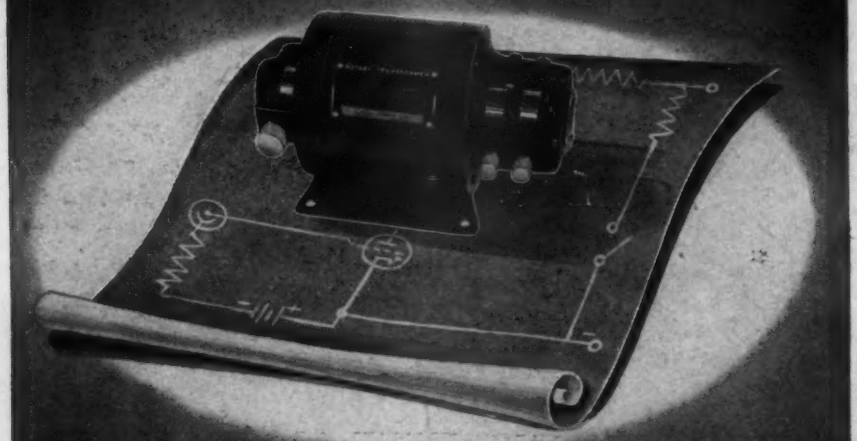
ASSEMBLIES COMPLETE WITH LAMPS:
We can supply any G.E. or Westinghouse Lamp together with the required Pilot Assembly, thus saving time in your production schedule . . . Write for samples.

Illustrated: (A) Neon Pilot Light with full-view plastic head. (B) Neon Pilot Light with dome lens. Lamps removable from front of panel.

We manufacture a complete line of Pilot Light Assemblies for every possible use in Aircraft, Marine, Radio, Electronic and Electrical apparatus. Send sketch for prompt estimates and suggestions.

SIGNAL INDICATOR Corporation
894 BROADWAY . . NEW YORK 3, N. Y.
Telephone: ALgonquin 4-4770

CARTER SOLVES YOUR *Dynamotor* PROBLEMS



For many years, Carter Dynamotors have been a familiar part of the specifications of leading Communication Equipment Manufacturers, Police Departments, Government Agencies, etc. May we suggest you submit your Dynamotor requirements too, and see for yourself the reason for this recognized preference.

The latest catalog of Carter Dynamotors, Converters, Permanent Magnet Generators and Dynamotors, and special rotary equipment will be sent upon request.

Carter Motor Co.
Chicago, Illinois

1606 Milwaukee Ave. Carter, a well known name in radio for over twenty years. Cable: Genemotor

Fixed Interval and Repeat Cycle Timers

SERIES 5800 CONTINUOUS running repeat cycle timers are available for either a-c or d-c operation, and with from 1 to 8 switches. Motor speeds depend upon the timing cycle desired. The manufacturer can adjust these timers to 1 revolution per six months if such timing is desired. ST or DT precision snap switches are used, and are rated ten amps, 110 volt, a.c.

Haydon Mfg. Co., Box 52, Forestville, Conn.

Cable Clamp

MODEL O-T CABLE CLAMP is for the use of radio, aircraft and electrical manufacturers. It is a compression type tool with all parts mounted or ringed on the cable axis to facilitate assembly time. All parts are locked by a simple

push-together and turning motion which results in a finished unit that is twist-proof, rupture-proof and water-proof. It is available in any size and shape and can be adapted to various types of jobs.

Oxford-Tartak Radio Corp., 3911 S. Michigan Ave., Chicago 15, Ill.

Magnet Wire Insulation Tester

THIS REPEATED-SCRAPE abrasion tester is a device for comparing the toughness of insulation on film-coated magnet wires. The equipment is particularly useful on wires which range in size from No. 10 to No. 30 (0.010 to 0.102 inch). It is portable and is easily operated, and consists essentially of an anvil, a clamp for holding the sample of wire, and a scraper head which is drawn back and forth over the film

Adlake *Plunger-type* Mercury Relays

STAMINA
SIMPLICITY
DEPENDABILITY

Adlake Relay No. 1040—(for A.C.)
5½" high, 2½" wide, 2⅛" projection. For panel mounting. Contact normally open or closed. Quick or time delay action. Contact protected by metal armor.

Automatic power control can be no more dependable than its relays. That is why the plunger-type mercury relay is replacing other types. It is the most dependable relay thus far developed for many types of service, because dirt, dust, moisture, temperature changes, humidity etc. can not affect its hermetically sealed contacts.

ADLAKE Plunger-type Mercury Relays are available for either quick or time delay action . . . for A. C. up to 440 volts . . . for D. C. up to 115 volts (and higher, with outside resistors) . . . and contact capacity from a fraction of an ampere to 100 amperes. All operate on the same basic principle. All are armored against outside impact. All have *hermetically sealed mercury to mercury contacts* which are *positive, chatterless, noiseless* and *arcless.* For complete data, request bulletin.

"Back the Attack—Buy Bonds"

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Radio transmission
Electric time controls
Photo-electric apparatus
Heating and ventilating controls
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Remote and automatic controls
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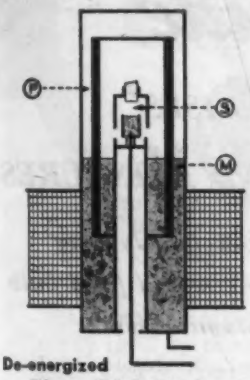
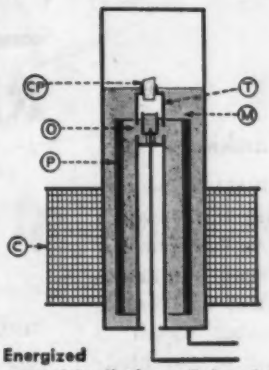
Refrigeration controls
Voltage regulators
Burglar alarms
Electric call systems
Across the line motor start switches
Motor reversing switches
Sign flashers
Animated displays
Telephone circuits
Mill and factory service
Navigation buoy flasher light controls
Dry cleaning equipment
Surgical lighting controls
Electrolysis prevention
X-ray control

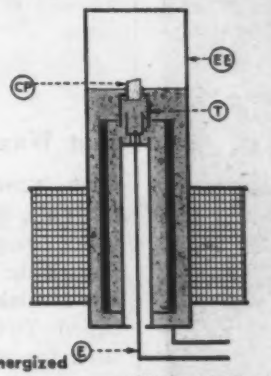
SIMPLE, UNFAILING, POSITIVE ACTION



De-energized
Plunger P is floating in mercury M. Space indicated by S is filled with inert gas.



Energized
Coil C pulls plunger P down into mercury M. Mercury thus displaced enters thimble T through orifice O. Inert gas in thimble has not yet escaped through ceramic plug CP, thus effecting time delay.



Energized
Mercury now fills thimble T, is completely leveled off and mercury to mercury *contact established between electrodes E and EE. Degree of porosity of plug CP determines length of time delay—and* accurately.

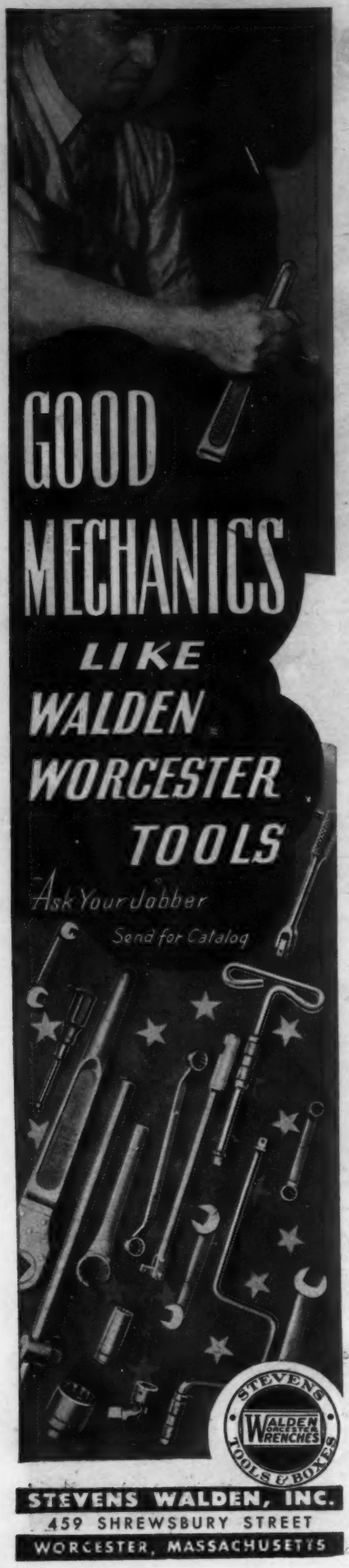
The above and accompanying sketches are *not* mechanical drawings. They show how Adlake Relays work, not construction detail.

Adlake TRADE MARK

THE ADAMS & WESTLAKE COMPANY

ESTABLISHED IN 1857 — ELKHART, INDIANA — NEW YORK · CHICAGO

MANUFACTURERS OF ADLAKE HERMETICALLY SEALED MERCURY RELAYS FOR TIMING, LOAD, AND CONTROL CIRCUITS



STEVENS WALDEN, INC.
459 SHREWSBURY STREET
WORCESTER, MASSACHUSETTS

surface by a motor-driven eccentric mechanism. Each revolution (considered one scrape) requires one second. A steel sewing needle is used as the abrading device. A set of weights provide the necessary pressure for conducting the tests.

The tester is illustrated and described in Bulletin GEA-4166 and is available from General Electric Co., Schenectady, N. Y.

Rayon Coil Winding-Tape

KAPPA CELLULOSE ACETATE rayon coil winding tape is designed to provide approximately 52 percent increased tensile strength. The tapes are available in standard widths from ¼ to 1½ inches and in consistent 3, 5, 7 and 10 mil thicknesses. The manufacturer states the average breaking load of 10-mil samples (1 inch wide) recently tested by an independent laboratory was 71.2 lbs. The strength will increase or decrease proportionately for other widths. Other advantages of the tapes are uniform impregnation with smooth, completely sealed surface free from pinholes; less varnish is needed; longer insulation life; higher dielectric breakdown; and non-corrosive characteristics.

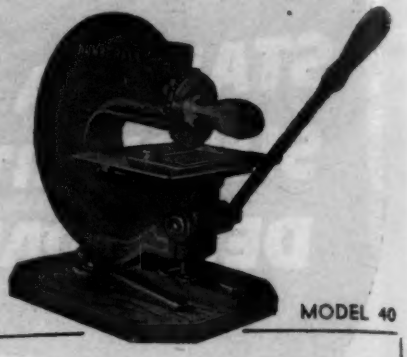
William E. Wright & Sons Co., Industrial Div., West Warren, Mass.

Hot Wax Dip Tanks

TWO NEW ELECTRICALLY heated, portable, hot wax dip tanks which meet Army-Navy specifications for packaging for overseas shipments are available. The first of these is called Twin Waxmaster which is used for wax dipping or for heating wax for spray lines. It has two hot wax dip compartments (insulated) in one tank. Thermostats provide positive temperature control from 100 to 550 degrees F. The second tank is called Waxmaster Senior because it is a larger adaptation of the model just described. It measures 25 x 25 x 9¾ inches and will heat and melt up to 24 lbs. of solid wax in 50 minutes without discoloration or scorching.

Aeroil Burner Co., Inc., West New York, N. J.

• NUMBERALL •
NUMBERING and LETTERING PRESS


MODEL 40

Quickly stamps serial numbers and other details on name plates, names and numbers on tags, etc. Can also be furnished for HOT stamping. Write for catalog.

NUMBERALL
STAMP & TOOL CO.
Huguenot Park Staten Island, N. Y.

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NEON XENON MIXTURES

Linde
RARE GASES AND MIXTURES

. . . *Spectroscopically Pure*
. . . *Easily removed from bulb without contamination*

Scientific uses for Linde rare gases include—

1. The study of electrical discharges.
2. Work with rectifying and stroboscopic devices.
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4. Work with inert atmospheres, where heat conduction must be increased or decreased.

Many standard mixtures are available. Special mixtures for experimental purposes can be supplied upon request.

The word "Linde" is a trade-mark of
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In Solid or Laminated Silver

The extremely delicate, supersensitive equipment used in modern warfare requires raw material that can contribute its share of high quality. Collector Rings, such as used in Radar, signal communication, auto-syn motor, searchlight and other equipment, fall in this category. Today, manufacturers rely on the improved performance and longer life obtained from General Plate collector rings made from solid or laminated silver in whose manufacture, electroplating has no part. General Plate rings are true to dimension and produced in a wide range of diameters, thicknesses and widths. Joints in the larger diameter rings are silver soldered and hardly visible.

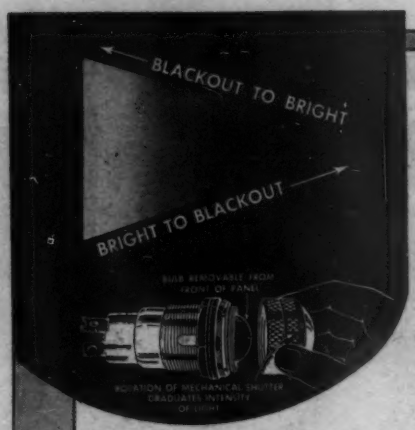
If your manufacturing of equipment calls for collector rings, it will pay you to consult General Plate. Our engineers will work with you on your requirements.

General Plate Division

of Metals & Controls Corporation

Metals and Controls Corporation Divisions manufacture the following products: Laminated & solid precious metals, electrical contacts—Solid and rolled plated precious metals in all forms—Truflex Thermostat Metals.

ATTLEBORO, MASSACHUSETTS



NEW..
"ONE-INCH"
VARIABLE
DIMMING
PILOT LIGHT
ASSEMBLIES
by DIALCO

To regulate the intensity of light, this new Dialco unit *has a superior mechanical shutter built into the knurled head.* This Vari-Dim Jewel Head assembly can also be readily applied to any of the CS series of Pilot Lights listed in our 24-page Catalogue No. 43. Write for a copy.

Plus LAMPS...
To help speed production, Dialco offers Pilot Lights completely assembled with G.E. or Westinghouse Lamps—any type or voltage. Samples submitted on request.

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Telephone: ALgonquin 4-5180-1-2-3

Pointing the way....

WITH UNERRING ACCURACY

Today, as a result of American engineering skill ingeniously applying amplification principles to highly specialized instruments, thousands of amplifiers by "Eastern" help to guide our army and navy bombers with unerring accuracy in successfully completing their vital missions.

Our engineering staff invites your inquiry—large and small production runs, even single units, receive our usual prompt attention. *Write for Bulletin* **98.**

BACK THE ATTACK ★
BUY WAR BONDS ★

EASTERN AMPLIFIER CORP.
794 E. 140th St., New York 54, N.Y.

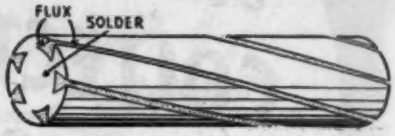
Interelectrode Capacity Meter

THIS DIRECT-READING instrument (Model 27) provides accurate measurement of vacuum tube interelectrode capacitances. It has a range of from 0.001 to 100.0 mmfd, with an accuracy of 5 percent or better on all five steps. On the lowest range, increments as low as 0.00001 mmfd may be used. Measurement is made at radio frequency in a crystal-controlled circuit having all voltages automatically regulated for maximum operating stability.

Bulletin A-344 describing the construction and use of this meter is available from Technical Apparatus Co., 1171 Tremont St., Boston 20, Mass.

Fluxed Wire Solder

A NEW TYPE OF FLUXED wire solder (called Fluxrite) contains flux in longitudinal grooves on the surface rather than in the core. The flux liquefies and flows onto the work before the solder melts. It is always visible to the user and can be quickly checked to detect gaps or voids. The solder is available in



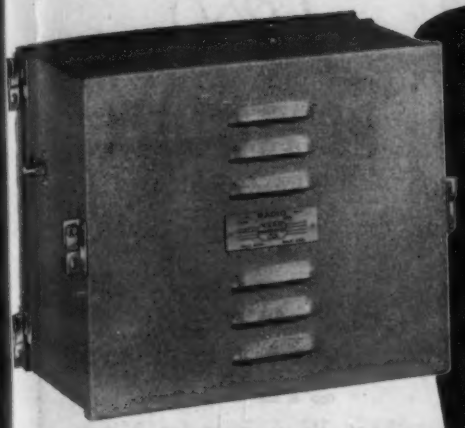
the same diameters as regular cored solder and comes in two compositions designated as Red Stripe and Green Stripe. These color designations are for easy identification.

National Lead Co., 111 Broadway, New York, N. Y.

Literature

Controls. Bulletin 697 contains 8 pages of data on standard, midget, sub-midget and elf radiohms, as well as switch covers, shafts and bushings that apply to this manufacturer's controls. Parts, detailed engineering drawings, specifications and resistance curves are included. Centralab Div., of Globe-Union Inc., 900 E. Keefe Ave., Milwaukee, Wis.

Look how easy it is to service KAAR *Mobile* RECEIVERS



1 The Kaar 11-X receiver is installed beneath the dash, and held securely by bolts through firewall.

2 For simple servicing, such as the replacement of tubes, the dust cover is removed by releasing two convenient snap catches. Takes but a moment.

3 For complete servicing, the entire chassis can be removed from the vehicle by releasing four snap catches. All wiring is instantly accessible.

FOUR CATCHES EXPOSE ENTIRE UNDERCHASSIS FOR SWIFT SERVICING

There is no "get out and get under" when it comes to servicing or checking Kaar receivers...they can be lifted out of a vehicle in a matter of seconds. In fact, the speed with which they can be serviced is one of their most popular features.

Another is the no-signal squelch circuit which automatically silences the receiver except when a call is actually being received. This is a blessing in military, civil, or private radiotelephone communication, where a wavelength must be guarded and continual background noise jangles the nerves.

The 11-X is operated by a control unit which can be mounted on the underlip of the dash. This unit contains a jewel light to indicate when receiver is on, a squelch circuit switch, and a combination volume control and power switch.

The Kaar 11-X receiver is crystal controlled, and may be tuned for any frequency from 1600 to 2900 KC.* (For frequencies between 30-40 MC. specify the Kaar PRS-9X.)

**Special ranges to 7000KC available on special order.*

KAAR
ENGINEERING CO.
PALO ALTO • CALIFORNIA

Manufacturers of high grade mobile and central station
RADIOTELEPHONE EQUIPMENT AND ACCESSORIES

Export Agents:
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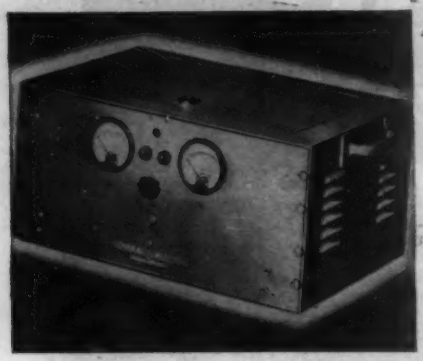
301 Clay Street
San Francisco 11, California, U.S.A.

REGULATED POWER SUPPLY



THIS power-supply unit is used in electronic research and development laboratories for amplifiers, television pulse generators, constant-frequency oscillators, high-speed electronic counting devices—wherever moderate amounts of d-c power are required within the voltage range of from 250 to 450 volts.

Designed in the famous G-E laboratories, this is only one of the new General Electric line of ELECTRONIC MEASURING INSTRUMENTS. A wide choice of compact apparatus for service maintenance and research include: G-E unimeters, capacitometers, audio oscillators, wide band oscilloscopes, square wave generators, signal generators, and other units for measuring electronic circuits and checking component parts.

• We invite your inquiry for G-E electronic measuring equipment made to meet your specific requirements.

FREE CATALOG

ELECTRONICS DEPARTMENT
GENERAL ELECTRIC CO.
Schenectady, N. Y.

Please send, without obligation to me, the General Electric Measuring Instrument Catalog, E-4 (loose-leaf), for my information and files.

*Name*_____
*Company*_____
*Address*_____
_____

GENERAL ELECTRIC
177-C4A
Electronic Measuring Instruments

Indent Type Electrical Connectors. "Hydent" connectors are for use in a wide variety of applications in marine, aircraft, electronic and electrical manufacturing industries and Technical Bulletin No. 6050 gives detailed information about them. Burndy Engineering Co., Inc., 107 Eastern Blvd., New York 54, N. Y.

Glass-Bonded Mica Insulation. An attractive brochure called "Mykroy" (the name of glass-bonded mica insulation) gives all the pertinent data and contains many illustrations of this electrical insulation, which is available in ample quantities and can be supplied in various forms. A free sample of insulation is contained in an envelope in the back of the brochure. This envelope is provided as a handy file in which material may be kept for reference. Electronic Mechanics, Inc., Clifton, N. J.

New House Organ. "Allied News" is the name of a new house organ which is published as a service to engineers, technicians and users of radio and electronic equipment. The idea behind this publication is to keep its readers posted on new products, provide data on development in the electronic field, and to survey topics of general interest. Allied Radio Corp., 833 W. Jackson Blvd., Chicago 7, Ill.

Industrial X-Ray Units. Picker 250-kv industrial x-ray units are available in jib crane, mobile and dolly types and are completely illustrated and described in Bulletin 1144. Picker X-Ray Corp., 300 Fourth Ave., New York, N. Y.

Capacitors. Various Army-Navy type bathtub capacitors; oil-filled oil-impregnated can type capacitors; and various mica capacitors are available for immediate deliveries and are listed in a 4-page folder (Form XI) available from Sprague Products Co., North Adams, Mass.

Electronic Tubes. Catalog No. RS gives complete information and technical data on phototubes, rectifier tubes, and grid control tubes (Thyratrons) available from The Continental Electric Co., Geneva, Ill.

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Sheet, Wire, Brazing Alloys

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Is Setting New Records of Dependability and Efficiency

Modern war, with its rigorous demands on communications equipment, requires vibrator power supplies that can operate under great extremes of heat, cold and humidity, and are able to withstand terrific jolts and jars.

The Vibrapack meets these conditions unfailingly in its use with our armed forces. Military restrictions prevent our showing the latest Vibrapack units, but here are some of their features:

Hermetically-sealed vibrators and other components . . . rigid anchorage of parts to withstand abnormal vibration . . . special mechanical designs and mountings, including duplicate mountings for replacement of other equipment . . . wide band and special band RF "hash" filtering . . . multiple input and/or output voltages, including independent bias supplies and AC or DC filament power in addition to plate and screen potential.

With these and other Mallory improvements, the Vibrapack carries tremendous implications for new-born products of today and tomorrow. If you are looking for a method of obtaining high voltage DC current from a low voltage source, we shall be glad to send you further information.

*Vibrapack is the registered trademark of P. R. Mallory & Co., Inc., for vibrator power supplies.

Hermetically-Sealed MALLORY Vibrators

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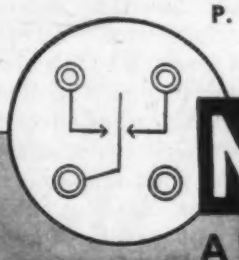

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AND VIBRATOR POWER SUPPLIES

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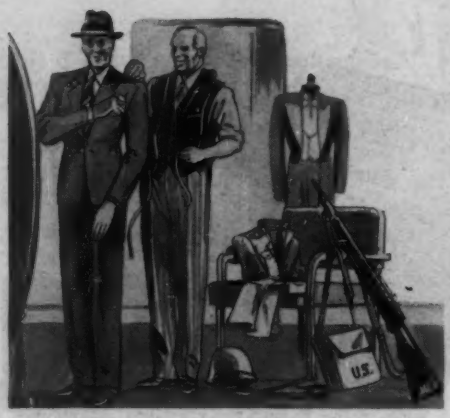

★ The manufacturing today of many parts and products for electronic equipment used in America's great military machine is grooming The Astatic Corporation for an important role on the electronic peacetime stage being set for tomorrow. On many fighting fronts and in many wartime industries, Astatic's Microphones, Pickups, Cartridges, Radio Co-axial Cable Connectors and certain electronic unmentionables are now aiding materially in the prosecution of the war.

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Mica spark plugs are a vital part of our high-speed Dive-Bombers. NO OTHER MATERIAL could stand the terrific changes in temperature encountered at high altitudes!

FORD RADIO & MICA CORP.

Joseph J. Long, President

538 63rd Street Brooklyn, N. Y.

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Radio Components. A new and comprehensive 46-page catalog contains detailed information, dimensions, specifications, blue prints and photographs of a complete line of sockets, plugs, terminal strips, switches, assemblies, and plastic fabricated parts. A. W. Franklin Mfg. Corp., 175 Varick St., New York 14, N. Y.

Induction Heating for Steel Parts. A 32-page book entitled "The Tocco Process" describes the application of this process in induction heating of carbon steel. Chapters in the book cover The Underlying Principle; Metallurgy of the Induction Principle; Carbide Solution; a table of Hardness Tests; Superhardness; Equipment (a 15-kw induction heating machine is described in this issue of ELECTRONICS in the "New Products" column); Surface Hardening; Heat Treating; Normalizing and Annealing; Brazing and Soldering; and Heating for Forging and Forming. The author of the book is the research and development engineer (Dr. H. B. Osborn, Jr.) of Tocco Division, The Ohio Crankshaft Co., Cleveland 1, Ohio.

Radio Frequency Lacquer. The name of this lacquer is Q-max, A-27, and its electrical and physical properties are given in a 24-page booklet called "Q-max." Also illustrated graphically, for a wide frequency range, are the dielectric constant, power factor and loss factor. Data are included for dielectric strength, density, drying time, adhesion and other characteristics. Communication Products Co., 744 Broad St., Newark, N. J.

Structure Manual of Prefabricated Steel. To aid engineers now engaged in post-war planning, there is available a 40-page book "Lindsay Structure Manual" which describes this strong, light-steel, prefabricated construction that can be assembled with simple wrenches and which may be used for cabinets and enclosures on various types of electronic equipment, as well as in other industrial and marine applications. Lindsay and Lindsay, 222 W. Adams St., Chicago, Ill., or 60 East 42nd St., New York 17, N. Y.

TEAM BEHIND THE BOMBER TEAM

• Just as seven men fight as a team in a bomber, seven girls work as a team at a Sylvania Radio Tube assembly bench.

Thousands of fine precision radio tube parts are assembled into a finished product that must pass rigorous tests for ruggedness and sensitivity.

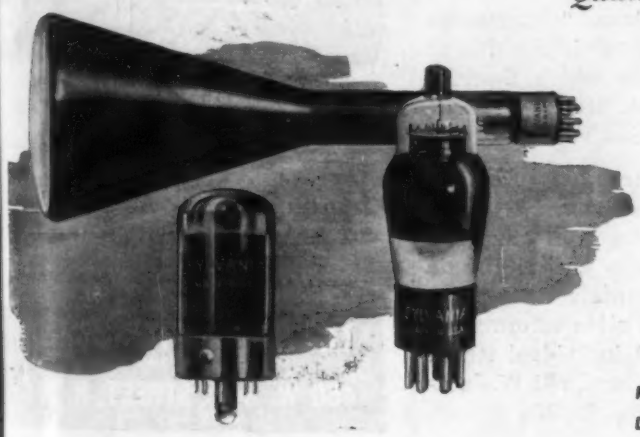
This is work that calls for the feminine touch, patience and sense of detail. Each girl "plays the position" on the team best suited to her ability.

Sylvania assembly teams compete with each other. But the champion in accuracy always takes precedence over the champion in speed.

This teamwork is just another example of how Sylvania maintains radio tube production at the highest standard of quality anywhere known.

You can sell Sylvania Radio Tubes with complete confidence.

Quality That Serves the War Shall Serve the Peace



RADIO DIVISION EMPORIUM, PENNSYLVANIA

SYLVANIA

ELECTRIC PRODUCTS INC.

RADIO TUBES, CATHODE RAY TUBES, ELECTRONIC DEVICES, INCANDESCENT LAMPS, FLUORESCENT LAMPS, FIXTURES AND ACCESSORIES

TECHNICAL NOTES

Excerpts from New Home Study Lessons Being Prepared under the Direction of the CREI Director of Engineering Texts

The Use of Thévenin's Theorem In Circuit Analysis

Many engineers have a reasonable knowledge of Ohm's Law, a bowing acquaintance with complex algebra (j operators), and a faint recollection of transient analysis and circuit theorems. In keeping with the purpose of the series of little articles appearing in the Institute's monthly magazine, the CREI NEWS, we are publishing a short article on the use of Thévenin's theorem in circuit analysis. We think it will interest the engineer because it enables him to analyze complicated circuits in terms of simpler, more fundamental ones, and obtain answers with a minimum of mathematical analysis. The increased use of Thévenin's theorem is evident from a comparison of radio text books of a few years ago, and those being currently published.

We hope to continue the discussion of the use of circuit theorems in future issues of the CREI NEWS, and also to take up topics, such as active perameters, that are seldom more than mentioned in radio texts.

Your comments and suggestions will be very welcome. This implies that you are reading the articles as they appear in the CREI NEWS. If not, all you have to do is to write to us in order to be placed on our mailing list. *We shall be glad to send you the article on "Thévenin's Theorem" in the March issue of the CREI NEWS without cost, and without your incurring any obligation whatsoever.*

★ ★ ★

The subject of "Thévenin's Theorem" is but one of many that are being constantly revised and added to CREI lessons by A. Preisman, Director of Engineering Texts, under the personal supervision of CREI President, E. H. Rietzke. CREI home study courses are of college calibre for the professional engineer and technician who recognizes CREI training as a proven program for personal advancement in the field of Radio-Electronics. Complete details of the home study courses sent on request. . . . *ask for 36-page booklet.*

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ENGINEERING INSTITUTE
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PUNCH IN HOLES INDICATED FILE IN YOUR NOTEBOOK

Photoelectric Colorimeters. A folder on Lumetron photoelectric colorimeters (Model 400-A and Model 400-G) describes and illustrates these instruments which are designed for speed and accuracy in colorimetric and turbidimetric analysis. Photovolt Corp., 95 Madison Ave., New York 16, N. Y.

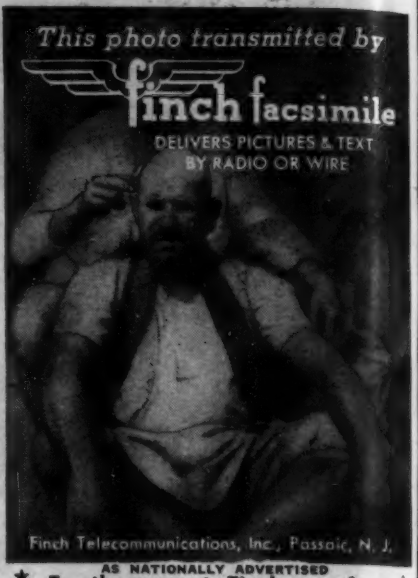
Signal Systems. "Cannon Signal Systems" for the modern hospital is the title of the new 16-page catalog which describes and illustrates nurses call and doctor's paging systems, registers, time recorder, special switches and light. According to the manufacturer the leading feature of these systems is a new single dial-control. The systems may also be used in factories or large offices where paging must be done silently. Signal System Dept., Cannon Electric Development Co., 3209 Humboldt St., Los Angeles 31, Cal.

Inter-Communication Systems. Catalog 1944 describes and illustrates many types of models of complete inter-communication systems available in 10, 20, 30, 40, 50, 60, 80 and 100 stations. Talk-A-Phone Mfg. Co., 1219 W. Van Buren St., Chicago, Ill.

Guide for Settling Cancelled War Contracts. This Guide tells how to organize a claims division; how the claims division can function efficiently; what forms to use; and how to expedite the payment of claims. It was written by J. J. Carroll out of his experience in supervising the settlement of claims resulting from eighteen million dollars worth of cancelled contracts. The book is published by Cope Inc., 3800 Chester Ave., Cleveland 14, Ohio, and is available for $2.50.

Vacuum Tube Data. "Gammatron Electronic Products" is the title of bound data sheets which describe Gammatron tubes. Heintz & Kaufman Ltd., South San Francisco, Cal.

Radio and Electronic Equipment. This new, 1944 catalog, No. 94, is a catch-all of the latest supplies available for radio and electronic equipment. It contains 104 illustrated pages and gives information on nearly 50,000 individual items. Lafayette Radio Corp., 901 W. Jackson Blvd., Chicago 7, Ill.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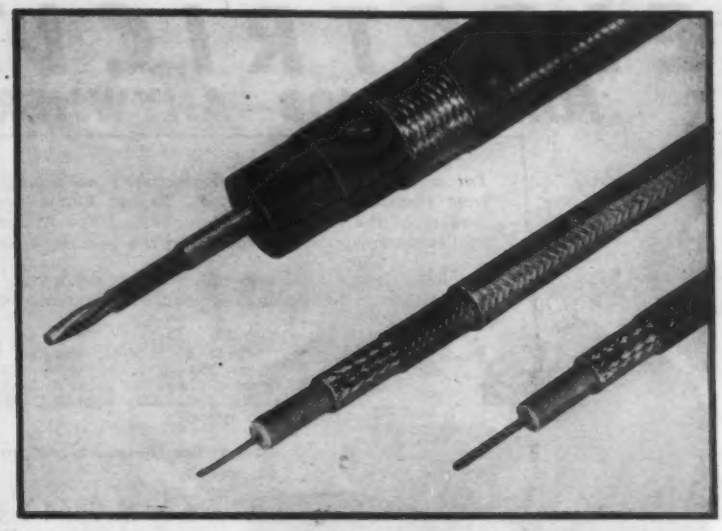
Typical Okonite Cables for electronic uses



THE APPLICATION OF SYNTHETIC INSULATIONS TO { Co-Axial Cables / High Voltage Cables / High Frequency Cables }

The success of Okonite cables designed for today's electronic applications depends on work started over 10 years ago by Okonite Research engineers when they first commenced to use synthetics. Some types such as neoprene, koroseal, vinylite, and thiokol were soon found to have immediate applinations, although there seemed to be no ready application for certain other types which had unusual, distinctive characteristics.

With the start of the war and the rapid progress made in extending the range of electronic equipment, cables were demanded having insulations with characteristics quite different from those used for ordinary power applications. The early research only then began to bear fruit and some of these new synthetics provided the answers to other war-time problems. The accompanying tabulation lists several of the synthetics available for use on cables and indicates their possibilities. Some already are used daily in our regular cable production. Others are only awaiting a need as yet unidentified. Perhaps you have a problem we can solve with these or other synthetics. Why not state your cable needs and let Okonite engineers make recommendations. We have both the equipment and the "know how" that can help provide a solution.

Typical Synthetic Materials with Promising Characteristics for Use on Electronic Wires and Cables

Name	Chemical Type	Use on Cable	Dielectric Constant	Power Factor	Dielectric Strength	Resistivity	Physical Properties	Oil Resistance	Resistance to Ozone and Sunlight
BUTYL RUBBER	Isobutylene-Diolefin Copolymer	Insulation	E	E	F	E	G	P	G
POLYBUTENE	Isobutylene Polymer	Insulation	E	E	F	E	F	P	E
POLYTHENE	Ethylene Polymer	Insulation	E	E	E	E	E	F	E
KOROSEAL	Plasticized Vinyl Chloride Polymer	Insulation or Jacket	F	F	G	F	G	E	E
VINYLITE	Plasticized Vinyl Chloride Vinyl Acetate Copolymer	Insulation or Jacket	F	F	G	F	G	E	E
BUNA S	Butadiene-Styrene Copolymer	Insulation or Jacket	G	G	G	G	G	F	F
BUNA N	Butadiene-Acrylonitrile Copolymer	Jacket	P	P	P	P	G	G	F
NEOPRENE	Chloroprene Polymer	Jacket	F	F	F	F	G	G	E
THIOKOL	Organic Polysulfides	Jacket	P	P	P	P	F	E	E

E—Excellent, G—Good, F—Fair, P—Poor. Physical properties include tensile strength, elongation, modulus, toughness and abrasion resistance.

3596

THE OKONITE COMPANY

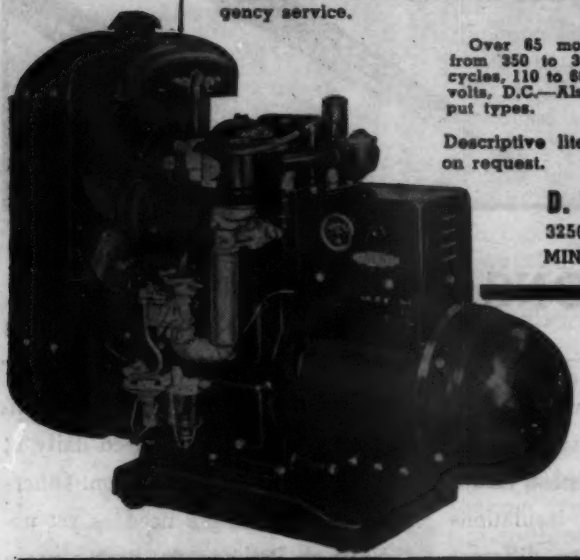
PASSAIC — OKONITE — SINCE 1878 — NEW JERSEY

Wires and Cables Insulated with Rubber, Varnished Cambric, Paper, Glass and Synthetics for Control, Communication, Power and Lighting in the Electrical and Electronic Fields

ELECTRICITY
FOR ANY JOB—ANYWHERE

For a dependable source of electricity on projects remote from commercial power, Onan Electric Plants are proven leaders in the field. More than half of the Armed Forces' total requirements for Power Plants are built by Onan.

Gasoline-driven . . . Single-unit, compact design . . . Sturdy construction . . . Suitable for mobile, stationary or emergency service.



Over 65 models, ranging in sizes from 350 to 35,000 watts, 50 to 800 cycles, 110 to 660 volts, A.C.—6 to 4000 volts, D.C.—Also dual A.C.—D.C. output types.

Descriptive literature sent promptly on request.

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Awarded to each of the four Onan Manufacturing Plants

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ELECTRIC PLANTS

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FOR
Electrical Equipment
Aircraft Instruments
Speed Indicators
Accurate Gauges

Made from appropriate materials selected for electrical resistance, minimum drift requirements, and endurance life. Furnished with or without collets—and with ends bent as desired.

HAIR SPRINGS

F·N· MANROSS & SONS
DIVISION OF BRISTOL
ASSOCIATED SPRING CORPORATION
CONNECTICUT U·S·A.

Variable Capacitors. These capacitors are for radio and electronic heating uses. A 4-page folder (designated as Condenser Catalog 75-C) gives complete information on this line of heavy-duty capacitors. Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.

Radio, Electronic and Electrical Parts. "Approved Precision Products" is the title given to the 1944 catalog which includes radio, electrical and electronic parts. Sizes, dimensions and rated capacities, together with list price are given. P. R. Mallory & Co., Inc., 3029 E. Washington St., Indianapolis 6, Ind.

Cowl Fasteners. Engineering and procurement data are contained in Catalog AD-2 which is a new reprint of the manufacturers' catalog published in July 1942. It is a 30-page booklet, printed on white coated paper, and contains all the pertinent data one needs to know about these fasteners. Aviation Division, Shakeproof Inc., 2501 N. Keeler Ave., Chicago, Ill.

Gage and Gage Instruments. "Quality Control" is the name of a new handbook on scientific inspection with DoAll gages and gage instruments. It contains 64 pages of descriptive literature and illustrations.

The purpose of the handbook is to give the reader a working knowledge of this phase of production. Continental Machines Inc., 1301 Washington Avenue South, Minneapolis 4, Minn.

Die-Less Duplicating Catalog. This catalog No. 44–6 is a newly revised and enlarged catalog containing descriptive data of Di-Acro Products. It contains data on two new machines recently added to the manufacturer's line of products—namely, the radius brake and Bender No. 3. O'Neil-Irwin Mfg. Co., Minneapolis 15, Minn.

STERILAMPS, used to irradiate newly hatched chicks, have reduced mortality to less than one-third during the first 16 days of life. Chicks given the treatment reached in five weeks a weight previously attained in eight.

STANDARD FREQUENCIES — *Octaves of them*

FREQUENCIES

10, 20, 40, 60, 80, 100, 120, 140, 160, 180, 190

Accuracy: 10 parts in 1,000,000
Output: 30 volts at 500,000 ohms
Input: 105-125V, 50-60~, 40 watts
Weight: 50 pounds

Impossible? Well, here it is—

This Multi-frequency generator furnishes the frequencies shown above at the turn of a switch. All frequencies are obtained from a temperature-compensated tuning fork and voltage-stabilized circuit.

With this unit it is possible to calibrate oscillators at many selected points without encountering complex oscilloscope patterns. One of the uncertainties involved in development work on tuned circuits, filters, reeds—and in time measurement can be minimized with the aid of this instrument.

Developed primarily to check frequency meters for precision war work, this Multi-frequency generator possesses a rugged durability and dependability in service that will prove an extra value to many laboratories.

Additional information available on request.

Manufacturer of the Watch Master

and distributor of Western Electric Watch-rate Recorders

American Time Products, INC.

580 Fifth Avenue New York 19, N. Y.

Electrical Papers

WHAT PAPER
for
HIGH TENSION
Wire Wrapping?

There is no one paper to meet all specifications — characteristics must vary with the job. A recent Central solved example was a request for a paper similar to cloth for hand-winding — it had to have stretch so it would wrap tight and hug the wire; strength and weather resistance; plus softness for protection to the operator's hands.

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Medical Electronics

(*Continued from page* 101)

been married for years without becoming pregnant, this procedure was successful and they now have healthy children.

The equipment used includes a microvoltmeter such as is diagrammed in Fig. 1, associated with a photoelectric recording galvanometer. Non-polarizable, reversible silver, silver-chloride electrodes were used, immersed in a physiologic salt solution from which rubber tubes were connected to the patient. The positive electrode, terminating in a rubber diaphragm packed with cotton saturated in normal salt solution, was placed over the cervix uteri (lower cylindrical portion of the uterus). The ground electrode was led to a sponge rubber disc strapped on the ankle. The electrode technique is of particular importance, and although the method is simple, it is necessary to exercise care to avoid air bubbles in the leads, and other conditions which might introduce artefacts into the record. The shift is not rapid, and devices with relatively slow time constants are quite satisfactory.

The voltage difference between the cervix and the ankle normally appears from 5 to 25 millivolts, with the cervix positive during the menstrual period. A pronounced negative shift of the cervix, which may appear at any time during the cycle, is believed to indicate the time of ovulation. The data accumulated recently indicate that ovulation occurs at irregular intervals throughout the cycle in the majority of women, and occasionally during the menstrual period. It is important to obtain a statistically valid quantity of evidence through the use of this procedure in the office practice of a large number of physicians. It would be desirable if apparatus were made commercially available, and undoubtedly the market for such equipment will grow as the techniques are increasingly simplified and the validity of the method is more widely established.

(An article by Snodgrass, Rock and Menkin appearing in the De-

Tomorrow?

Will free enterprise prevail?
Will there be religious tolerance or intolerance?
Will racial prejudices grow or disappear?
Will labor-management bog down before selfish-interest blocs?
Will commerce and industry be restricted or expanded into a world wide renaissance?

The answer is in what each of us thinks and does. Do-nothing wailers will be with us always, but they are the small minority. The pioneering spirit that made America the envy of the world still runs strong in our veins. A new industrial era is already well under way in which thermoplastics is carving a leading place in tomorrow's civilization.

"One ship sails east, and another west,
By the selfsame winds that blow;
It isn't the gales, but the set of the sails
That determine which way we go".

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ENGINEERS
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A non-profit research laboratory engaged in urgent war research must increase its scientific staff. MEN OR WOMEN (COLLEGE GRADUATES), with experience in vacuum tube circuit design, construction of aircraft radio equipment and design of small electro-mechanical devices are needed.

Salaries range from $3,000 to $8,000, depending upon experience, ability, education and past earnings. Release statement and USES consent needed.

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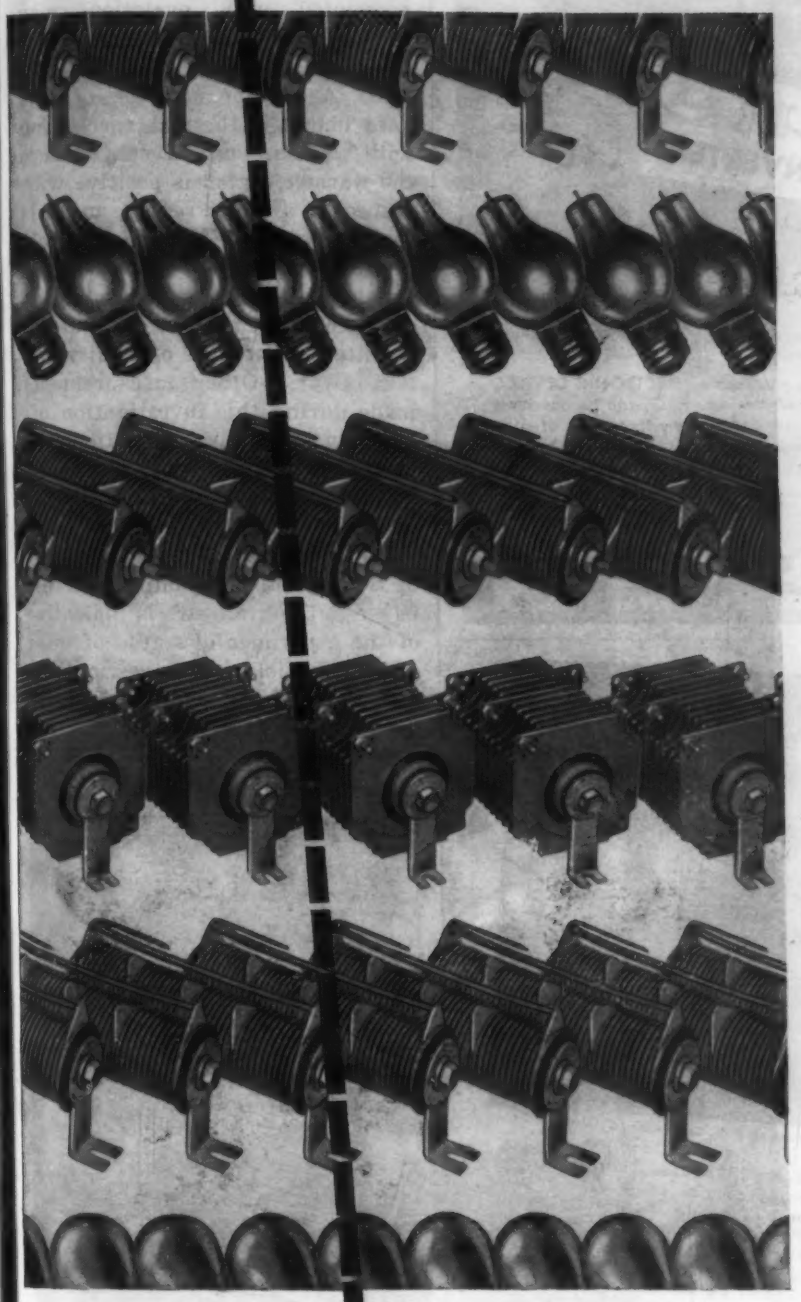


Where other manufacturers offer one or two of the three standard types of low-voltage rectifiers, General Electric is alone in supplying all three—an important fact to remember when next you need a rectifying unit. The reason: The *most* efficient type in one application may be *least* efficient on the very next application. It is in determining which type to use in each instance that G.E. can help you most—having all three types it can give impartial engineering advice on which one you should use. Full details from Section A445-119, Tungar & Metallic Rectifier Division, General Electric Co., Bridgeport, Conn.

GENERAL ELECTRIC

The only manufacturer of all three types of Low-Voltage Rectifiers

SAVE STRATEGIC MATERIALS

BY USING SPEER GRAPHITE ANODES

Put SPEER graphite anodes in transmitting and rectifying tubes you make. *They save strategic materials.* You also simplify production by eliminating the need for expensive dies, and tube shrinkage is less of a problem because anode dimensions are constant and rigid. Then too, it's important to bear in mind that:

SPEER GRAPHITE ANODES

Increase allowable plate power dissipation.

Lower temperatures of associated tube parts.

Withstand severe overloads.

Defy warping.

Prevent hot spots or fused holes.

Minimize bulb darkening and insulator leakage.

Improve degassing qualities.

Decrease gas troubles.

Enhance tube appearance.

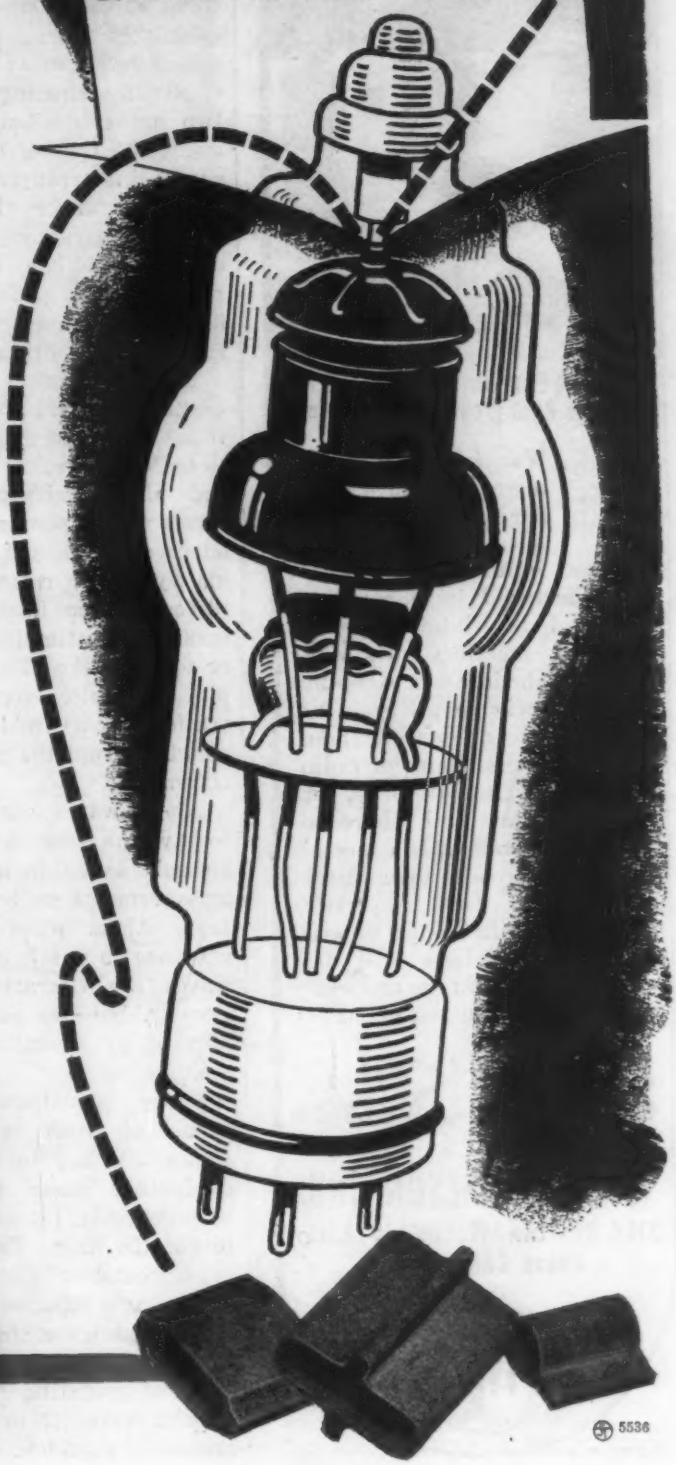
Provide precise anode dimensions.

Produce uniform tube characteristics.

Retain original dimensions in service.

Maintain normal tube characteristics.

Leading manufacturers now produce tubes with SPEER graphite anodes for all transmitting and rectifying requirements. Write for descriptive literature on SPEER graphite anodes.



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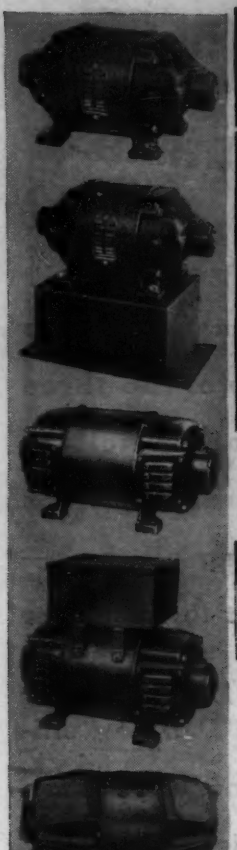


CONVERTERS

When only D. C. power is available, ELECTRONIC DEVICES requiring from 110 to 3250 volt-amperes A. C., can be operated by a rugged Janette rotary converter. Many thousands of such essential safety and other electronic devices, used on ships and shore stations, depend upon Janette converters for power.

Wherever there are ships, you will find Janette converters.

Janette

Janette Manufacturing Co. · 556-558 W. Monroe St. · Chicago, Ill.

X-RAYED!

TO INSURE PERFECT JOINT

"Photo by G. A. Russ, Claud S. Gordon Co."

Note elimination of junction boxes in right angle bends, designed and engineered by Andrew to meet exacting requirements of this special application.

Inner conductor is bent, not spliced. Outer conductor is mitered and silver soldered. X-ray insures no silver solder penetration into cable, eliminating danger of short circuit. Sealing and pressurizing transmission lines before plating prevents possible corrosion.

For *your* problems in radio antenna equipment, consult Andrew. The Andrew Co. is a pioneer in the manufacture and engineering of coaxial cables and accessories. Free catalog on request. Write today.

X-ray illustrates Andrew right angle coaxial cable assembly, part of a Fan Marker Beacon Transmitter made for CAA by Farnsworth Television and Radio Corporation. Pilots' lives depend on the 100% reliability of this equipment. Andrew is proud of the use of its coaxial cable in this installation.

ANDREW CO.

363 EAST 75TH ST., CHICAGO 19, ILLINOIS

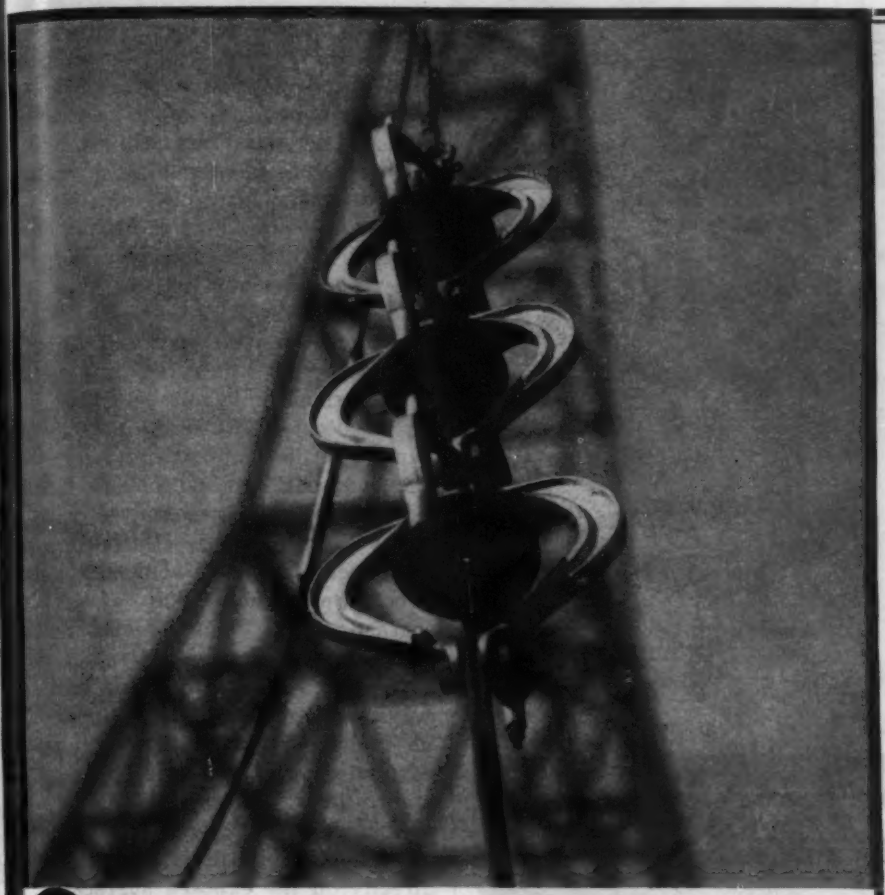
COAXIAL CABLES

cember 1943 issue of the *American Journal of Physiology*, volume 140, page 394, describes recently completed experiments indicating data which refute previous evidence of potential changes associated with ovulation. The summary of these investigations expresses a belief that the previously observed changes in potential believed to be associated with ovulation may merely indicate a period which is favorable for successful fertilization. A further outcome of this data shows a thermal correlation with bioelectric currents where the warmer region is positive with respect to a cooler region, and this in turn appears to be intimately related to changes in pH (the negative logarithm of the concentration of the hydrogen ion in gram atoms per liter—a measure of acidity and alkalinity). Other measurements made during this investigation offered an interesting indication that right and left handedness may be correlated with the potential difference between the hands, the positive side indicating the handedness of the person. The addition of this paper to the literature is indicative of the experimental status of most electro-physiological investigations and the need for an increasing in-

• • •

WELDING CONTROL

The circuit of an energy storage welding control, used for welding aluminum aircraft sub-assemblies, is examined by Edward Clayton Hartwig, U. of Missouri '43, and member of the Westinghouse graduate student course. Originated 50 years ago, the course helps graduates bridge the gap between academic preparation and actual production work



Do you recognize these insulators?

They are the first radio tower insulators made in this country. They were designed and built by Locke for the original wireless telegraph stations.

That was a long time ago and every day since has added to our skill and experience. Research facilities available nowhere else in the industry have been in constant use finding better, simpler, lower cost methods of producing the finest in radio insulators.

Whether your requirements are standard or special, we think you will find them better filled by Locke.

A COMPLETE "CLAY"RAMIC SERVICE

For every electrical, chemical and mechanical application, Locke has unrivalled facilities for the production of fired clay pieces by every known method.

(1) Dry Process — Porcelain and Steatite

A process ideally suited to the production of certain pieces with reasonable tolerances and adequate mechanical and electrical strength.

(2) Vacutite Process—Porcelain and Steatite

A process developed by Locke for forming intricate pieces. Close tolerances. Mechanical and electrical strength almost equal to wet process.

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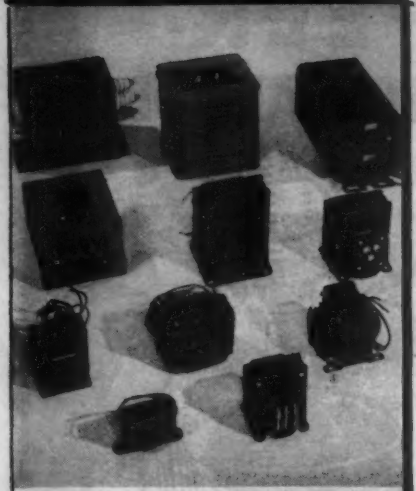

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terest in this field by competent research workers.)

Electroencephalography

The electrical activity associated with grey matter, commonly called brain waves, is recorded on paper or film according to a variety of techniques, or observed visually on oscilloscopes. The desirability of a long base line on the oscilloscope has led to the development of circuits for successive sweeps displaced vertically so that as many as three screen width lines may be effectively observed at once.[24] Another development makes use of electronic switching to superimpose two or more channels simultaneously. (A further reference to the use of this arrangement appears in this text under the sub-heading Electromyography.) A great deal of material has been published regarding the problems in amplifier design connected with the low frequencies of brain waves.

The normal brain produces Alpha (8-12 per second, 10 to 125 microvolts) and Beta (18-30 per second, 10 to 20 microvolts) wave patterns, and also rambling, unorganized waves at 2-7 per second, up to 50 microvolts. When the patient closes his eyes and relaxes, the Alpha waves become increasingly prominent, but a stimulus, such as light or sound or the effect of doing simple arithmetic—voluntary concentration on a problem, may completely disrupt the pattern of these waves.

Alpha waves are also observed to have the same characteristics in animals as in humans, and even measurements on beetles show the same Alpha wave variations in response to a stimulus. The Beta waves are characteristically less regular, but are not so obviously affected by stimulation or mental activity.

These potentials are usually picked up with small lead electrodes attached to the scalp with conducting paste and sealed on with collodion. It is not necessary to cut the hair. The shunt effect of surrounding tissues is considerable, and voltages measured directly from the cortex during operative procedures are in a higher order of magnitude.

Delta waves (1 to 4 per second) appear in profound sleep or anes-

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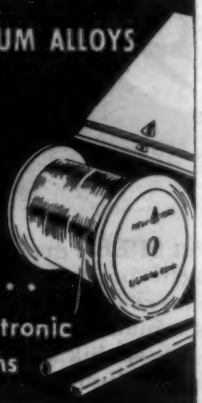

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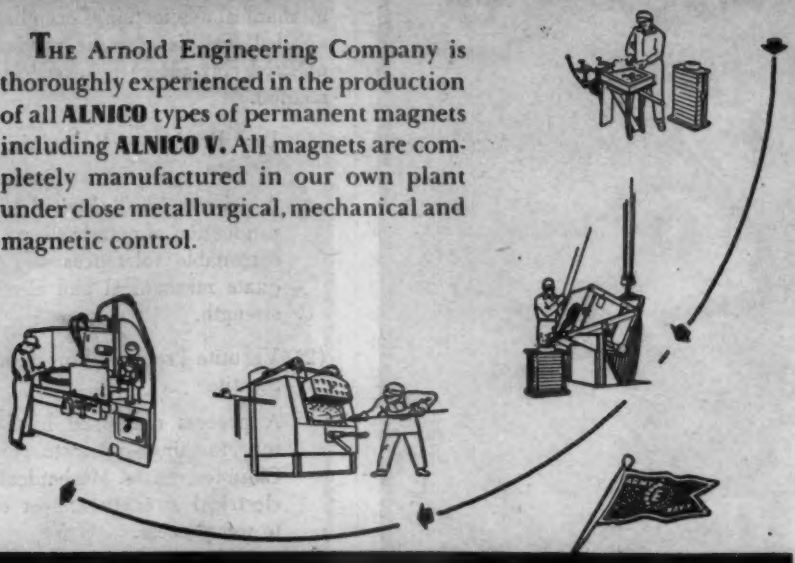

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thesia; in general, the rythms are all slower during sleep, irregular, and of higher voltage.

When abnormal conditions are present in the brain, spikes and slow Delta waves reaching 200-500 microvolts appear. Periodic dysrhythmia of this kind is usually an indication of epileptic seizures, and may be correlated in magnitude and duration with severity and length of the attack, ranging from a few seconds to several minutes.

Abnormal high voltage patterns are also caused by blood clots and tumors on the brain, and by a series of triangulation measurements it is possible to locate these sources with great accuracy.[35, 36] Multichannel equipment greatly facilitates the procedure. The value of this method to the diagnostician and surgeon is incalculable.

Most large hospitals have brain wave departments, and since nearly an hour is required to obtain an adequate record, they are kept constantly busy.

Considerable experimental work has been done with measurements directly on the exposed surface of the cortex (outer portion of the brain including gray matter) in humans,[37] to obtain a more intimate knowledge of the electrical components of brain cell activity. Gen-

• • •

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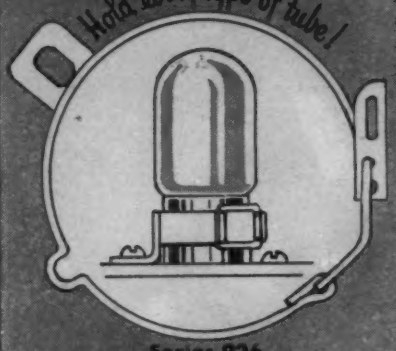

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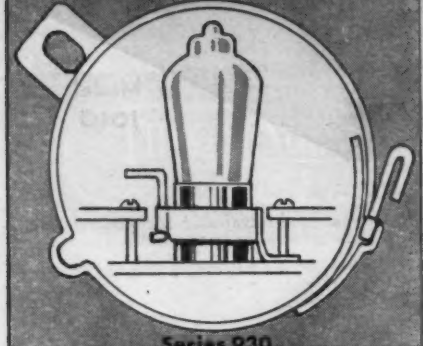

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erally these operations are accomplished under local anesthesia with the patient fully conscious.

Motor centers are located by applying electrical stimulation directly to the cortical surface and correlating the response from the patient. Thus it is possible to localize the areas in which control of various portions of the body is centered. Some surgeons have used this procedure for determining the area causing convulsions in epileptics, and have achieved a measure of success with surgical removal of this portion of the brain.

Recordings obtained directly from the cortex have demonstrated that tumors are themselves inactive electrically, and the slow wave patterns characterizing their presence result from damage to adjacent tissues. Light-weight silver wire is used for electrodes in these measurements, and care must be taken to avoid brain damage resulting from piercing the surface coating (pia mater).

A great deal of data have been accumulated to obtain empiric correlation between brain waves and psychotic disorders, and many contributions are being currently made to the understanding of psychiatric problems.

There are many theories with regard to the source of Alpha and other brain rythms. An Alpha rythm appears in a state of repose with external and internal stimuli at a minimum. One explanation of the Alpha rythm that has been suggested conceives of many nerve cells of the brain changing potential in unison or in such a time distribution that a ten-cycle overall pattern is measured. Embarrassment, close attention, nervous tension or environmental stimulus usually serves to reduce both the voltage and the amount of time in 30 seconds of recording occupied by the Alpha rythm (percent time Alpha). It may be possible to extend this analysis to explain the excessively high-voltage discharges found during convulsions. In this situation an increased number of nerve cells may be locked in step at an abnormal frequency or pattern. Such a condition may lead to the control of a great number of cells by one activity pattern in such a manner as to result in convulsions, unconsciousness, etc. This may be

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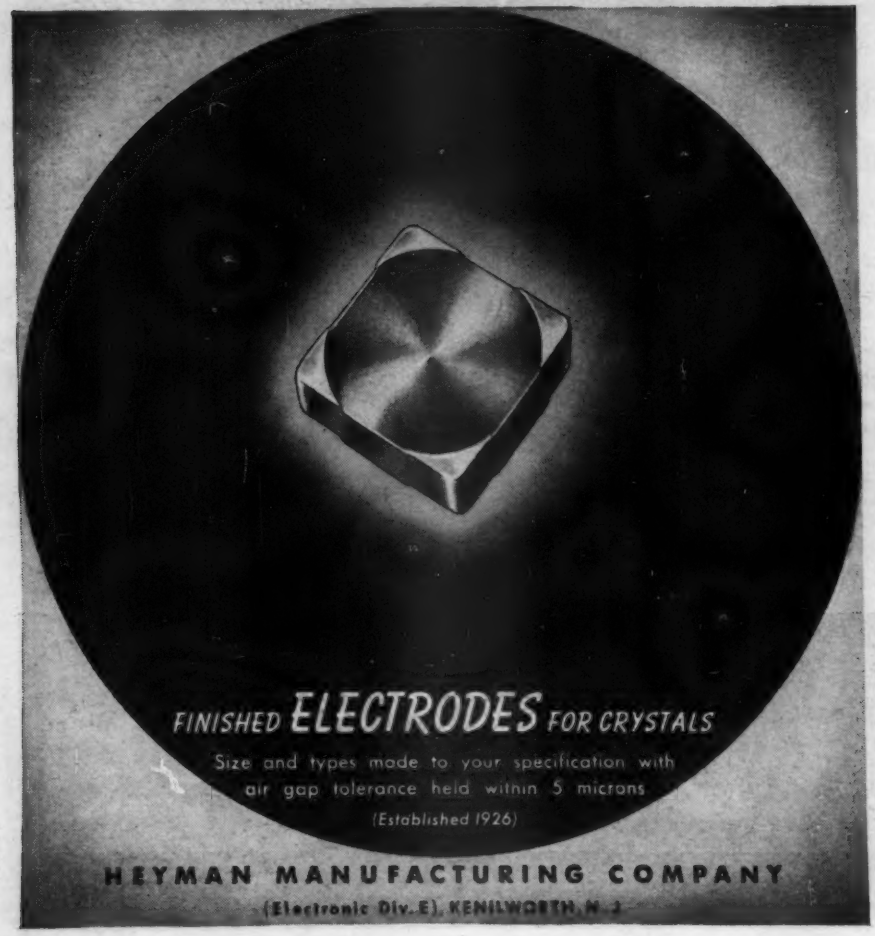
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conceived of as comparable to a telephone exchange—the lines are kept busy so that no other cerebral activity may occur. Disruption of the Alpha rythm by internal or external stimuli is an indication of changes in the temporal orientation of cell discharges when they are individually engaged in the processes of perception, motivation or ratiocination.

Electromyography

There are many possibilities of correlation between measureable electrical phenomena and physiological events. The increased fund of such knowledge is reaching constantly into new branches of diagnostic practice. Among the fields in which the available data is rapidly increasing, and hence the opportunity for practical use, is the study of muscle pathology.

Electrode techniques in electromyography (recording of muscle potentials) include surface discs applied in much the same manner as in electroencephalography, and coaxial needle electrodes where an insulated core is inserted in a hypodermic needle. In the latter case the needle is thrust into the substance of the muscle, with the outside of the needle grounded.

Often electrical measurements may be the means for determining the origin of a malfunction. In connection with conditions where muscles refuse to relax after voluntary contraction, the action potentials from the nerve endings

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have been shown to continue after the patient has made a voluntary effort to relax the muscle. This is interpreted as indicating that the problem is concerned with the stimulating mechanism rather than with the muscle tissues."[18]

A series of studies in connection with uncontrollable tremors has included comparisons between simultaneous recordings of brain waves and muscle potentials. No correlation was found to exist, and the data suggest that the origin should be sought in other areas of the central nervous system, such as the spinal cord."[19]

Dr. M. A. B. Brazier is currently active in research on poliomyelitis (infantile paralysis) and investigations of associated muscle disorders.[20] One of the interesting observations in certain neurological conditions is that a knee jerk applied to one leg sometimes produces an electrical discharge from muscles in both legs. The latent period between the two reflexes is too brief to measure with ink writing devices. An electronic switch developed by the DuMont Company is being used in an effort to determine the possible path of such crossed reflexes from the measured time interval between them. The electronic switch in conjunction with a

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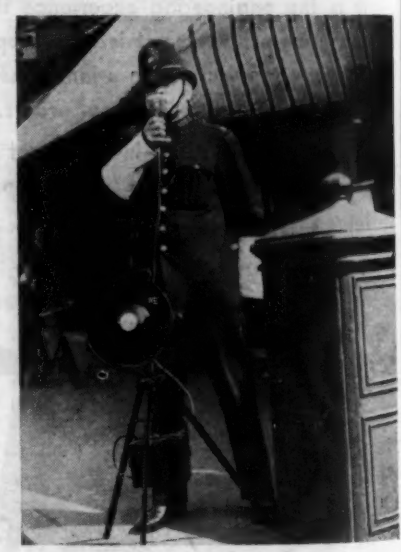

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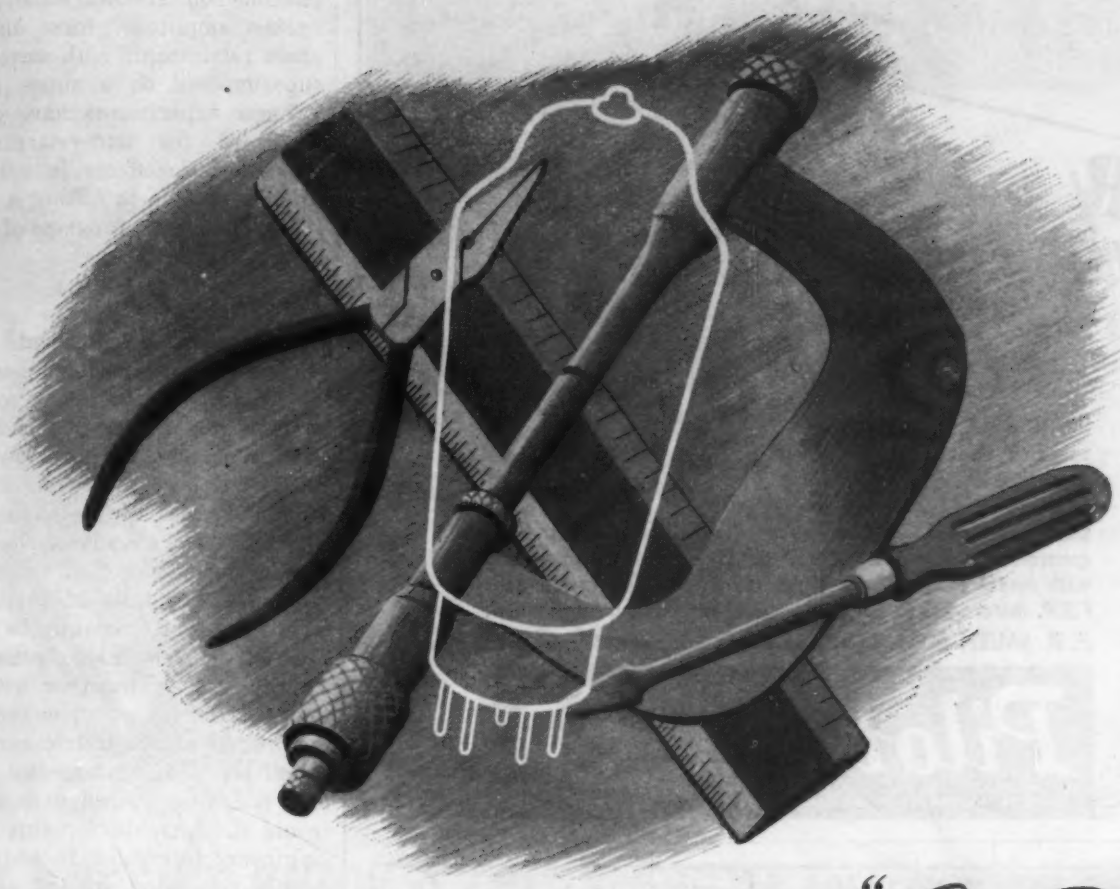

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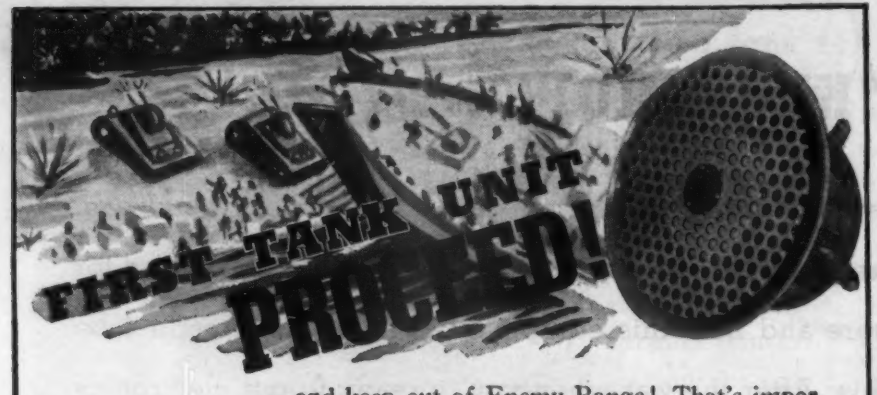

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These experiments have greatly increased the understanding of characteristic effects in poliomyelitis, as well as providing a means for following the progress of therapeutic treatments.

Summary

A survey of developments in the field of electrophysiology has been presented. The increasing scope of correlations between pathological conditions and electrical measurements has been indicated. The intimate relationship between living structures and associated electrodynamic fields has been discussed.

Technical details of procedures have been limited mainly to an indication of electrode techniques. These methods, together with the low frequencies and low order of magnitude of bioelectric currents, constitute the fundamental problems presented to designers of electronic instruments for this work. Engineers interested in additional details regarding specific applications are referred to the brief bibliography of "key" references given below, many of which contain extensive lists of related literature.

It is clearly evident that the elec-

• • •

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Communications operators of an artillery battery of the 8th Army at work in a communications truck. The mobile unit is also used as an advance observation post with ground fire

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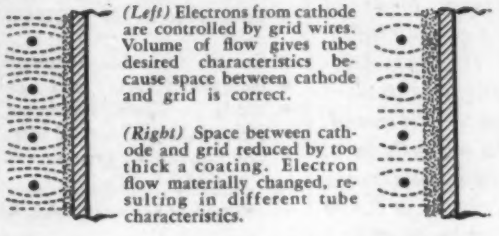

(Left) Electrons from cathode are controlled by grid wires. Volume of flow gives tube desired characteristics because space between cathode and grid is correct.

(Right) Space between cathode and grid reduced by too thick a coating. Electron flow materially changed, resulting in different tube characteristics.

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Acknowledgment is extended to Dr. A. J. Derbyshire of Harper Hospital and Wayne University, Detroit, Michigan, for reading this manuscript and providing helpful criticism and suggestions. Appreciation is expressed for the generous contribution of current information from R. F. Novotny, Rahm Instruments Inc., New York City; Albert M. Grass, Consulting Electrical Engineer, Quincy, Massachusetts; Lovett Garceau, Electro-Medical Laboratory, Inc., Holliston, Massachusetts; Dr. Franklin F. Offner, Offner Electronics, Inc., Chicago, Illinois; and Dr. John G. Lynn, Research Associate in Neurology, Columbia University, New York City, in addition to others mentioned in the text.

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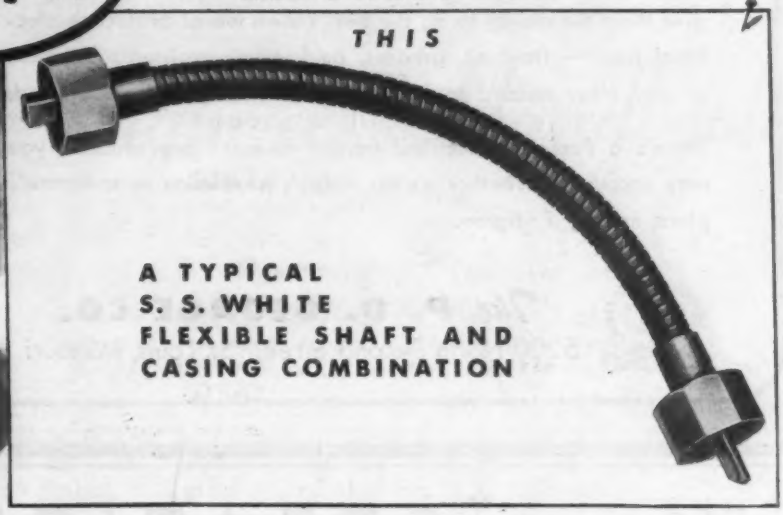

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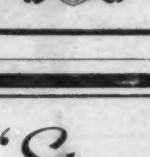
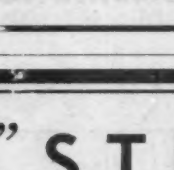

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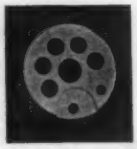
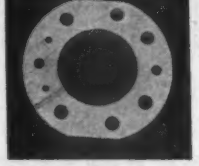

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By ARTHUR R. NILSON and J. L. HORNUNG, *McGraw-Hill Book Co., New York, Second Edition, 1943, 927 pages, price $6.00.*

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Technique of Radio Design

By E. E. ZEPLER, PH.D., *University College, Southhampton, England. John Wiley & Sons., Inc. 312 pages, price $3.50, 1943.*

Radio Receiver Design (Part I)

By K. R. STURLEY, PH.D., *Marconi School of Wireless Communication, England. John Wiley & Sons, Inc., 435 pages, price $4.50, 1943.*

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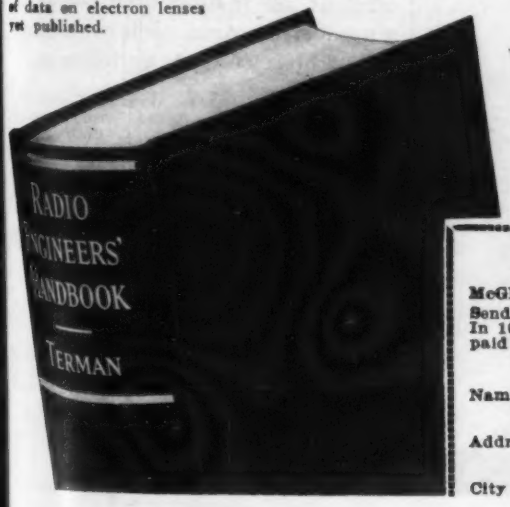

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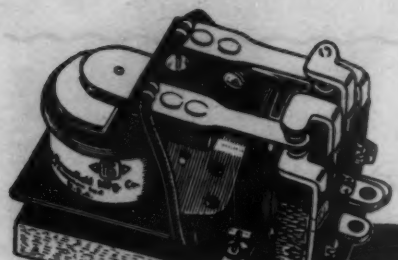

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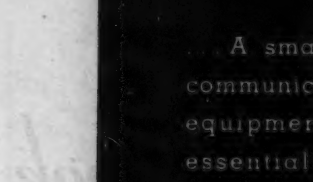

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By BRITISH STANDARDS INSTITUTION, *28 Victoria St., London, S. W. 1. In eight paper-covered parts ranging from 16 to 32 pages each. Price 2s per part, 1943.*

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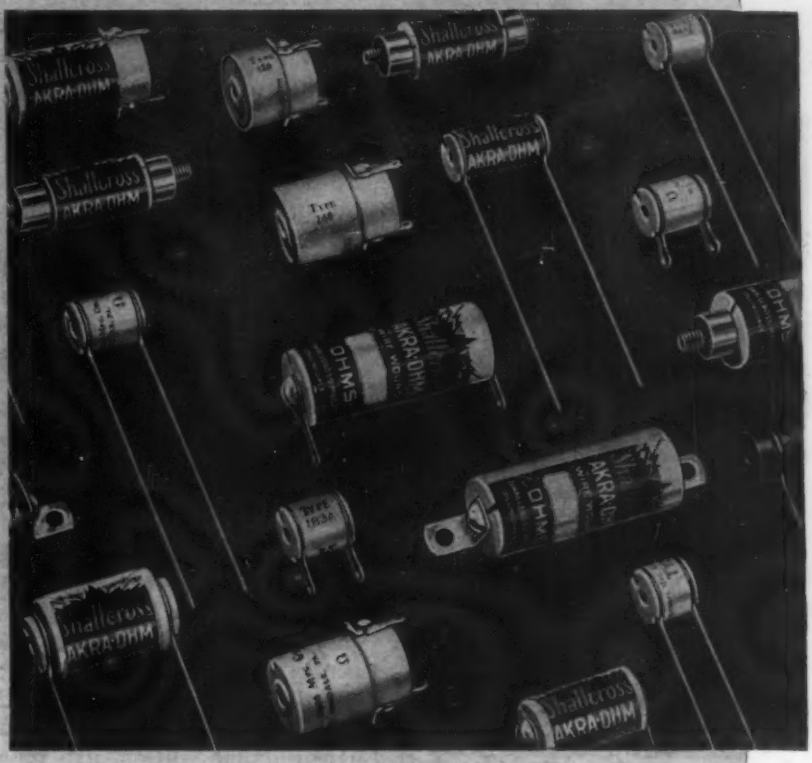

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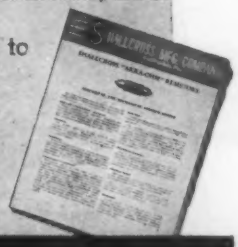

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By O. S. PUCKLE, *Research Department, A. S. Cossor, Ltd. London. John Wiley & Sons, Inc., New York. 1943, 204 pages, price $2.75.*

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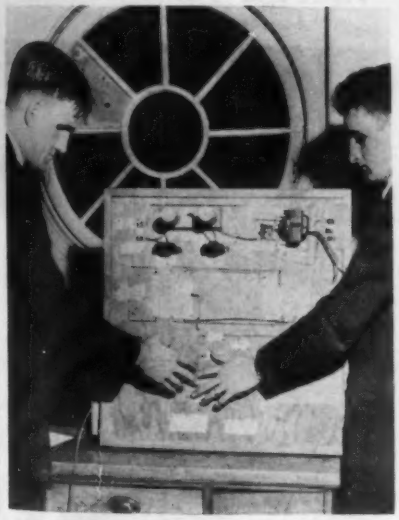

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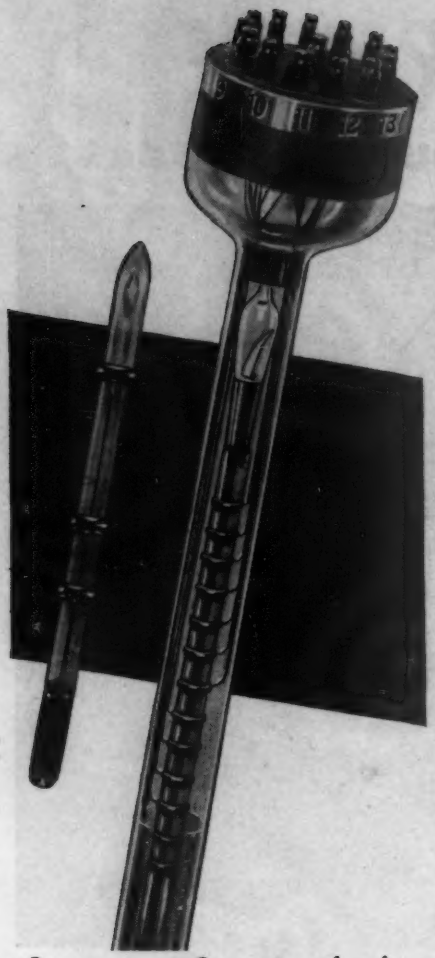

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Short Wave Wireless Communication

By A. W. LADNER, *Principal, The Marconi School of Wireless Communication, and* C. R. STONER, *Lecturer at Queen Mary College. John Wiley & Sons, Inc., New York, Fourth Edition (Reprinted from British book), 1943, 573 pages, price $6.00.*

IN MODERNIZING this British text to cover latest publishable theories and facts on American, English and European short-wave developments, the authors have carefully retained essential fundamental data. The first half of the book contains these essentials along with 75 pages on propagation, a chapter on high-frequency feeders and a chapter on aerials of various types. The remaining half of the book deals with power amplifiers, oscillators, velocity-modulating systems, the Klystron and similar modern developments that are playing such important roles in short-wave communication, detection and control today. There is a comprehensive chapter on high-frequency therapeutic apparatus, and three chapters on commercial communications equipment (chiefly British). This new wartime edition, like its predecessors, uses mathematics only when essential and then in a prac-

• • •

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electrical, chemical and other terms necessarily included because of their relation to civil engineering work.

There being considerable variation in the use of words among the eighteen Spanish-speaking republics of the Americas, local terms are given for words in this category, with identification of the countries in which they are used.

As with most two-language dictionaries, this book is divided into two equal sections. In the first, the Spanish words are listed alphabetically, each followed by its English equivalents. Example: *pila fotoeléctrica*, photoelectric cell. In the second section, English words are listed alphabetically and followed by Spanish equivalents. No definitions of the terms are included. Abbreviations are similarly handled in two separate tabulations.—J.M.

• • •

Mathematics of Radio Communication

By T. J. WANG, Ph. D., *Ohio State University. D. Van Nostrand Co., New York. 370 pages, 1943. Price $3.00.*

RADIO AND ELECTRONICS are engineering sciences which depend very greatly upon mathematical bases; and the worker in these fields who does not have good access to these tools finds himself severly handicapped. Any book, therefore, which helps the radio engineer review his

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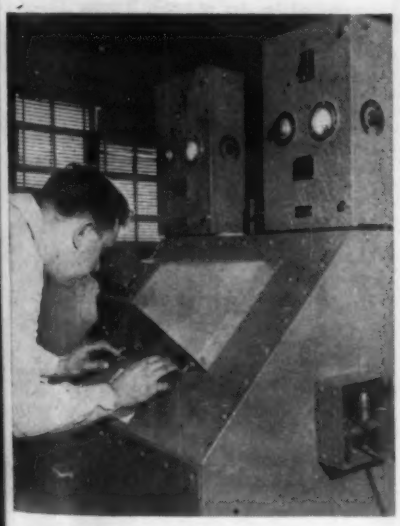

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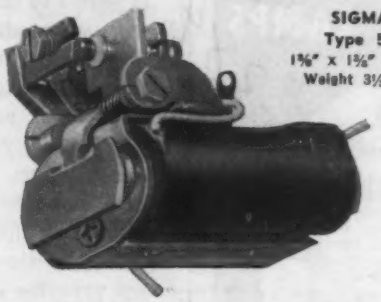

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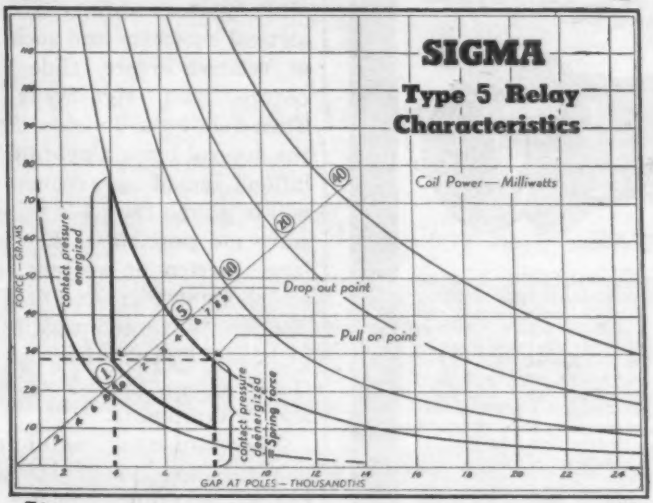

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The possibilities of this relay can be imagined when it is realized that a contact pressure of only 20 grams is sufficient (on the Series 5) to withstand 11 g's vibration.

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100. Ohms	7.07 MA — .707v.	2.24 MA — .224v.
1000. Ohms	2.24 MA — 2.24v.	.707 MA — .707v.
10000. Ohms	.707 MA — 7.07v.	.224 MA — 2.24v.
20000 Ohms	.500 MA — 10.00v.	.158 MA — 3.16v.

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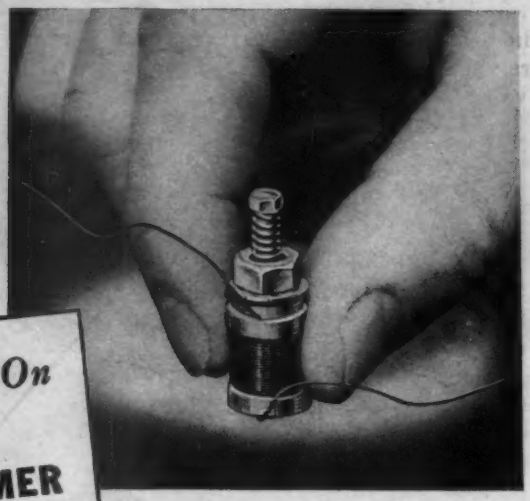

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bases, outlines the historical development of the methods, describes them, indicates how to produce a linear trace, a circular trace, spiral traces or any other sort of time base that may be desired for a specific purpose.

Such matters as trigger circuits, blocking oscillators, synchronizaton, generation of square waves, the multivibrator, naturally comes into such a book. In fact anyone wanting to be up-to-date on much modern technique involving transient conditions and pulses could learn a great deal by studying this little volume, despite the fact that English terms and American terms do not agree at times.—K.H.

• • •

Engineers' Dictionary—Spanish-English and English-Spanish

By LOUIS A. ROBB, *John Wiley & Sons, Inc., New York, 1944, 423 pages, price $6.00.*

COMPILED TO ANSWER a need in Latin America for Spanish equivalents of English engineering and construction terms. The field of the present volume is the vocabulary of civil engineering in all its branches, with many mechanical,

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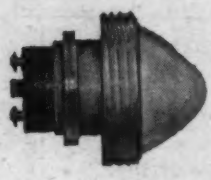

#180 . . . Molded #600 type socket; 2" glass beehive lens in screw mounted chromium cap; for uses requiring long distance and brilliant visibility from every angle; admirably suited for panels bearing heavy apparatus; Underwriters Approved for 120 V. (S6 bulb).

#555 . . . (N.A.F. 47940); High arched lens in chromium plated screw mounted cap; for double-contact candelabra bayonet bulb; ⅜" diameter mounting hole.

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mathematics, or which aims to initiate the radio man into the mysteries of mathematics, is an important book. Its value increases as some high powered function of its excellence.

It seems to this reviewer that Dr. Wang has produced a good book. It is not too simple; nor will the reader get stuck before he really gets started as is too often the case with many mathematical books which purport to be "refreshers."

The contents are divided broadly into fundamental processes including arithmetic and algebra; laboratory practice such as graphs, and other matters ordinarily called analytical geometry and such subjects as relative errors, slide rule procedure, and significant figures. Then follows a division devoted to the several basic algebraic manipulations including exponents. Next will be found the tools necessary to solve a-c problems; then a rather large section on vectors including complex notation; and finally a section on "advanced studies" which include differentiation, power functions, integration, Fourier series and determinants.

There are many useful problems; and the few typographical errors spotted by this reviewer will be more annoying to the author than to the reader.—K.H.

• • •

Basic Radio Principles

By MAURICE G. SUFFERN, *Captain, Signal Corps, Army of the United States. McGraw-Hill Book Co., New York, 1943, 271 pages, price $3.00.*

THE AUTHOR INTRODUCES this volume as a textbook designed to aid in the training of radio repairmen and technicians on a vocational-education level in a period of approximately 200 hours. Its goals include giving the student a knowledge of basic radio fundamentals, the ability to identify radio components and symbols, ability to interpret diagrams and an understanding of the principles involved in operation of the radio equipment.

A distinct innovation in textbooks is the use of multiple-choice questions at the end of each chapter for review purposes. The possible answers are carefully prepared, and provide a quick but informative check on student's mastery of the material.—J.M.

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Permanent Magnets

(*Continued from page* 139)

netic circuit is closed by the movable member *K*. Coil *C* is connected by means of a pair of twisted leads to a fluxmeter located some distance from the permeameter, and the fluxmeter pointer is carefully set at zero. Next, switch *S* is closed in position 1 and a heavy magnetizing current sent through coils *B*. The fluxmeter pointer will swing up scale. The number of turns on coil *C* must be such that this deflection is at or near the full scale mark. Under no circumstances must the pointer touch the pointer stop or the test becomes valueless.

After three or four seconds or until all motion of the fluxmeter pointer has ceased, switch *S* is opened. The fluxmeter pointer immediately drops part way down the scale and a reading of the fluxmeter is taken at this point. Next, making sure that resistance R_2 is at maximum value, switch *S* is closed in position 2 and a light demagnetizing current put through coils *B*. The fluxmeter pointer immediately drops further down scale. R_2 is then gradually decreased in value, the operator carefully watching the fluxmeter pointer as it approaches zero. When it reaches zero, the reading of ammeter A_2 is taken. Switch *S* is opened, the test piece removed, a new one inserted, and the cycle starts again.

The two readings taken during the progress of the test are proportional respectively to the B_r and H_c points of the demagnetization curve of the test specimen. Referring again to Fig. 6, when switch *S* is closed in position 1 the magnet operating point runs up the curve *oc*. Resistance R_1 must be adjusted so that the operating point goes beyond point *c*, i.e., so that the mag-

—◇—

AN OUTSTANDING EXAMPLE of simplification is the schedule for incandescent lamps. The number of types have been reduced from 3,500 to 1,700, the colors from 13 to 3, and the voltages from 32 to 7, a yearly saving of 35,000 lb of solder, 2,000 lb of tungsten, and 1,200,000 man hours of labor.

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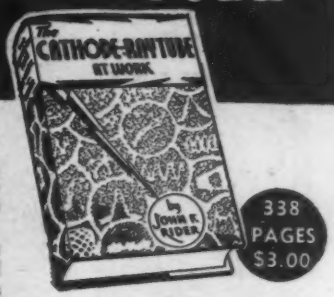

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Today it is difficult to find a laboratory where research is carried on in the radio, electrical and allied fields where the cathode-ray tube as a part of the cathode-ray oscillograph does not receive daily use.
This book represents a complete explanation of the various types of cathode-ray tubes and what role each element within the device plays in making visible the voltages and currents encountered in various kinds of tests.
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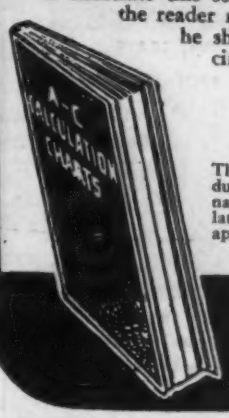
In this volume is complete and elaborate explanation of the theory of the tube. It is this information plus the practical applications, which make this Rider book so valuable.



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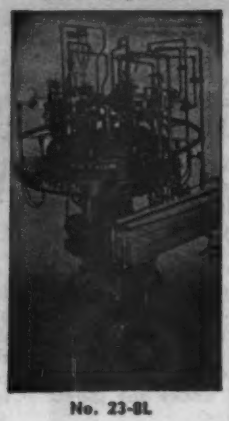

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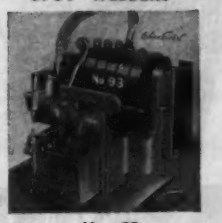

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net is saturated. When switch S is opened, the operating point drops down to point B_r, as the magnet is in a completely closed soft iron circuit and no magnetizing or demagnetizing influences are present at this time. When switch S is closed to position 2 and R_2 gradually decreased until the fluxmeter returns to zero, the magnet operating point runs down the demagnetization curve until it reaches point H_c. Now, since the value of demagnetizing current is read at this point, we have a reading which is proportional to H_c because the field in the gap is directly proportional to the current through the coils (assuming no saturation of the soft iron magnetic circuit).

Thus, while the production permeameter, like the magnetometer, gives no answers in absolute quantities, it does give two readings for each test piece, the first of which is directly proportional to the residual induction of the magnet and the second of which is directly proportional to the coercive force of the magnet. It is an excellent production testing instrument for the quality of large numbers of magnets.

Because its two readings are directly proportional to two of the cardinal points of the demagnetization curve of the piece under test, the production permeameter is sometimes thought to be a more accurate instrument than the magnetometer. This undoubtedly is the

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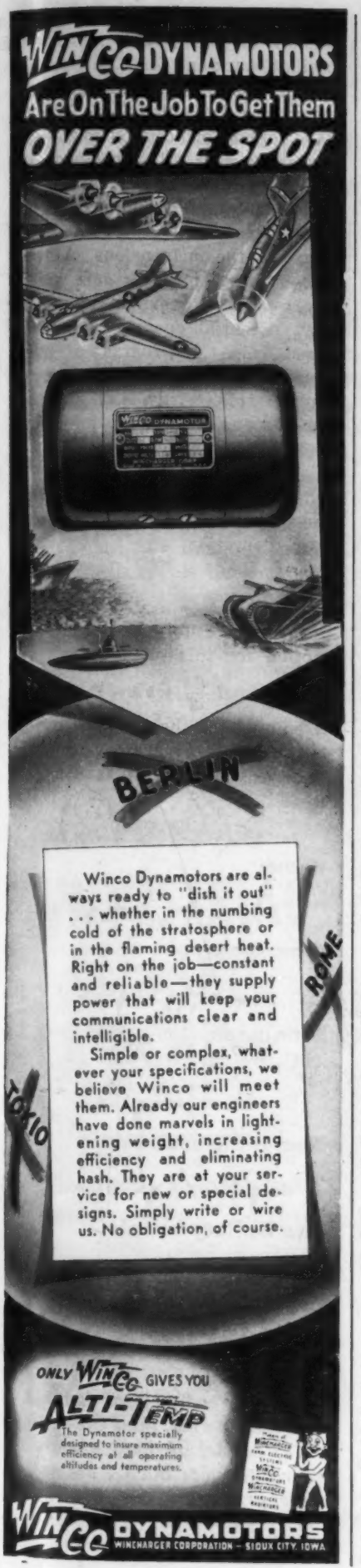
WALKIE-TALKIE IN FOXHOLE

The beachmaster's signaller of the British 5th Army landing force occupies a foxhole while awaiting orders near the village of Campoleone, 15 miles from Anzio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case, but the additional accuracy supplied is in most cases unnecessary. The additional speed and ease of operation of the magnetometer is also an important consideration. It is sometimes quite difficult to choose between these two instruments. The ultimate choice must be governed entirely by the needs of the user.

APPENDIX

Analysis of Ballistic Galvanometers

Only an undamped ballistic galvanometer shall be considered, as space does not permit consideration of all conditions of damping. Assume that the coil is located in the magnetic field to be tested and it is connected to the galvanometer. As the search coil is removed from the magnetic field a voltage is developed in its windings, and current flows through the galvanometer circuit. This current produces a torque, T, on the galvanometer moving coil which is proportional to the physical size of the moving coil and its number of turns, on the field strength (produced by the permanent magnets of the galvanometer) in which the moving coil is located, nd on the value of the current flowing through the moving coil. These factors may be broken up into those which are constants of the galvanometer and those which are not:

$$T = Ki \qquad (11)$$

Now, assume that it takes a length of time, t_0, to completely remove the search coil from the magnetic field under test. During this time current flows through the galvanometers' moving coil. At the end of t_0 the moving coil will have acquired a velocity, ω_0, and the kinetic energy of the moving system will be

$$E = \tfrac{1}{2} I \omega_0^2 \qquad (12)$$

where I is the polar moment of inertia of the moving system.

Since damping is not present in

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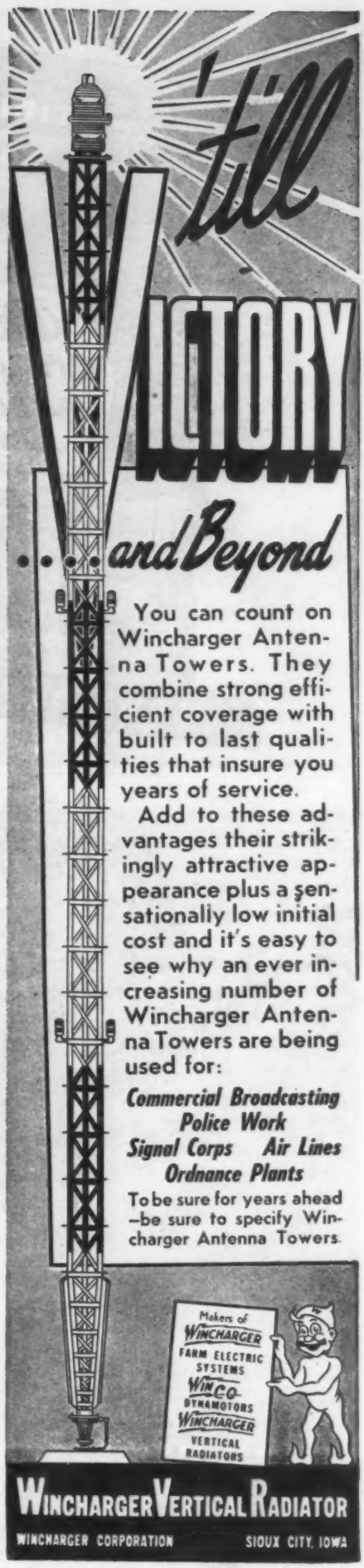
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the galvanometer under study, the amount of energy of Eq. (12) will oscillate back and forth between the moving system and the suspensions, appearing in full at one instant (the instant of no twist to the suspensions) as kinetic energy in the moving system, at another instant (the instant of maximum twist to the suspensions) as potential energy in the suspensions, and between these times as part kinetic energy in the moving system and part potential energy in the suspensions. At the instant of maximum deflection of the galvanometer, this energy is all stored in the suspensions and we may write

$$\frac{1}{2} I \omega_o^2 = \frac{1}{2} k \theta_m^2 \qquad (13)$$

where k is the spring constant of the suspensions, and θ_m is the maximum deflection.

Hence:

$$\theta_m = \omega_o \sqrt{I/k} \qquad (14)$$

Now, the differential equation of motion for this moving system is

$$I \frac{d^2\theta}{dt^2} + k\theta = T$$

Assuming for the moment that the torque, T, is a constant, the solution for this equation is

$$\theta = \frac{T}{k}\left(1 - \cos\sqrt{\frac{k}{I}}\, t\right)$$

whence

$$\omega = \frac{d\theta}{dt} = \frac{T}{\sqrt{kI}} \sin\sqrt{\frac{k}{I}}\, t$$

Consequently,

$$\omega_o = \frac{T}{\sqrt{kI}} \sin\sqrt{\frac{k}{I}}\, t_o \qquad (15)$$

Substituting Eq. (15) into Eq. (14), we get

$$\theta_m = \frac{T}{k} \sin\sqrt{\frac{k}{I}}\, t_o \qquad (16)$$

Now, if t_o is small so that

$$\sin\sqrt{\frac{k}{I}}\, t_o \leqq t_o \sqrt{\frac{k}{I}} \text{ (radians)} \qquad (17)$$

then Eq. (16) becomes

—◇—

SOME 76,210 applicants for commercial radio operator licenses were examined by FCC during its fiscal year ending June 30, 1943. In the same period, the FCC employed 2,153 people; of these, 382 are regular employees and 617 are national defense workers in Washington; 206 regular and 948 national defense employees are in the field.

$$\theta_m = \frac{T t_e}{\sqrt{k I}} \qquad (18)$$

Substituting Eq. (11) into Eq. (18), we get

$$\theta_m = \frac{K i t_e}{\sqrt{k I}} = \frac{K Q}{\sqrt{k I}} \qquad (19)$$

where Q is the total quantity of current flowing through the moving coil during the time, t_e.

Equation (19) shows the ballistic galvanometer to be a total-current-reading instrument. For simplicity, an undamped galvanometer was assumed in the analysis and it was assumed that the search coil was removed from the field under test in such a way that a constant torque, T, was applied to the moving coil of the galvanometer during the time, t_e. It may be shown rigidly that a ballistic galvanometer will read total current whether it be undamped, underdamped, critically damped, or overdamped, and that it will do this regardless of the wave form of the current impulse passing through it. The important requirement (true for all cases of damping) is that the condition of Eq. (17) be observed, wherein t_e is

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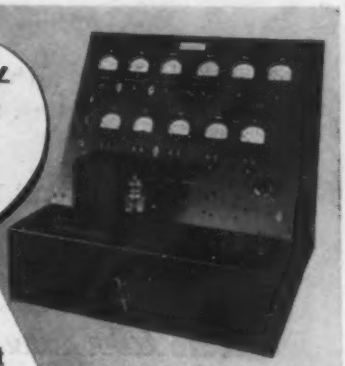

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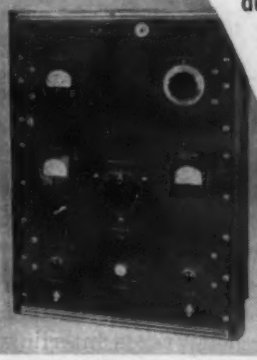

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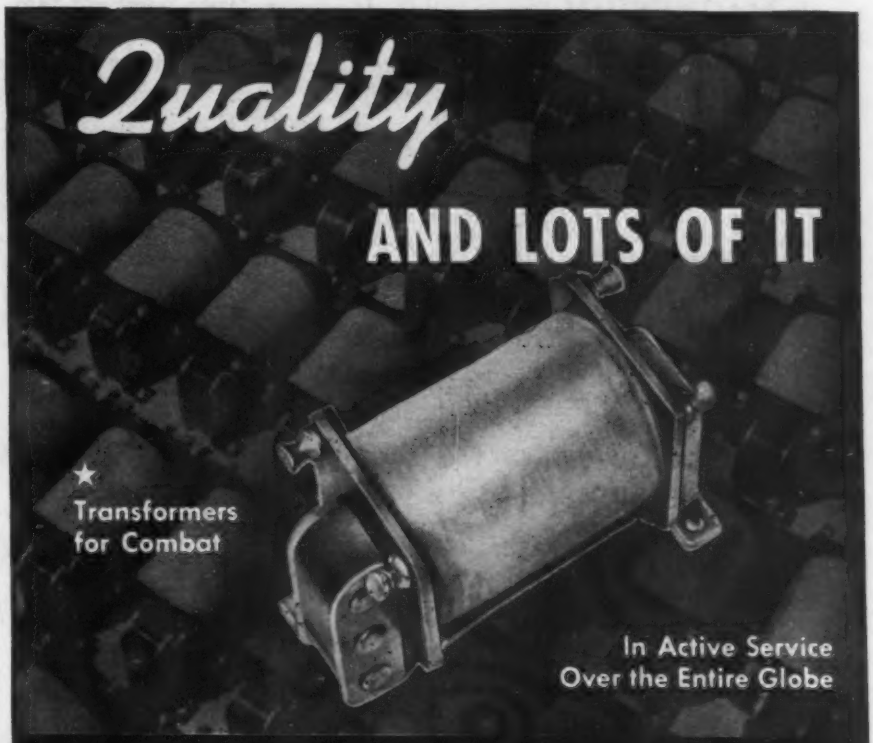

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kept small with respect to the natural period of the instrument.

When a search coil is connected to a ballistic galvanometer the electrical circuit consists essentially of only two elements—the search coil and the moving coil of the galvanometer. Now, if we neglect the self inductances of each of these elements (for simplicity and because these inductances are truly negligible compared to circuit resistances in most cases), and lump the resistance of the search coil with that of the moving coil, a summation of voltages around the circuit during the time, t_w, of withdrawal of the search coil from the field under test gives

$$N\frac{d\phi}{dt} \times 10^{-8} = iR = R\frac{dQ}{dt}$$

where N = number of turns on search coil

$\frac{d\phi}{dt}$ = time rate of change of flux lines through search coil

i = current through circuit.

R = total circuit resistance.

The constant of integration being zero, integration gives

$$N\phi \times 10^{-8} = RQ \qquad (20)$$

This equation shows that the ballistic galvanometer reads interlinkages, $N\phi$, as well as total current, Q. It also serves to point out that the sensitivity of one galvanometer may be high for Q and low for $N\phi$, while that for another galvanometer may be low for Q and high for $N\phi$, depending upon the circuit resistance.

• • •

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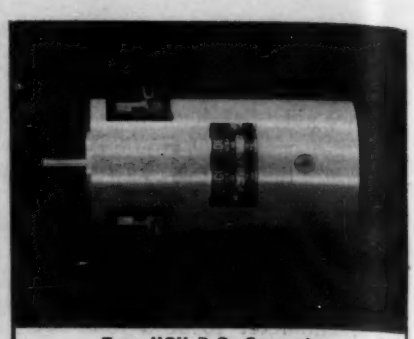

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Aircraft Skins

(*Continued from page* 107)

definitely with r-f heating. There are other minor advantages which will be apparent to those thoroughly familiar with the bag process.

In applying r-f heating to thin surfaces an interesting problem occurs in the choice of frequency. Loads of this type have relatively high capacitance. Thus, if they are to be tuned by an inductance of practical size the frequency used must not be too high. At the same time the highest possible frequency is desirable from the standpoint of keeping voltage gradient down. Because of these opposing factors, the frequency choice narrows to a small range. This may pose a problem if the day comes when an attempt is made to allocate certain frequency bands for r-f heating applications. In the present case a frequency of 4 Mc was found to be about right. However, should attempts be made to extend the use of this method to the larger pieces—some of which are 16 ft. by 8 ft. in size— a very

• • • •

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A telephone that generates power from the human voice was useful on Guadalcanal, the War Department reports. Under favorable conditions, messages could be received over ten miles of wire line. It was used for fire control of infantry mortars. Photo by U.S. Army Signal Corps

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much lower frequency, possibly as low as 500 kc, would have to be used.

Summary

The tests which have been described, together with others not related here, have been fairly succesful and have given results which show that r-f heating can be applied to the production of curved laminated and molded plywood parts, as well as to flat stock and spars. At the present time simple curved laminated parts such as wing tip bows and spar flanges are being made on a small scale in this way. To date there has been no actual production of molded shapes using r-f heating. The reasons are found in the more difficult application problems encountered and the small quantities of parts involved. Insofar as war production of wood aircraft is concerned, this situation will remain. However, post-war production in much larger quantities, not only of wood aircraft parts but also of molded and curved parts for other uses, may well justify the work and expense required to adapt r-f heating for applications of this kind.

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DIAL TELEPHONE SUBSCRIBERS in Holland overload the lines during daytime hours, apparently as delaying technique for sabotage. German occupation officials have warned that they "will not hesitate to exclude a large number of subscribers from telephone communication if the obstruction does not disappear through subscribers' cooperation"

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Conserving Small Tubes

(*Continued from page* 142)

good operating condition. This tradition has, unfortunately, persisted into the present time. The almost universal use of heater-type tubes today does not justify the practice.

Present-day tubes generally become unusable because noise or distortion develops, usually as result of reduced emission. Since this is a gradually-changing condition, weekly or even monthly routine distortion measurements or listening tests will indicate when replacement is required.

Belief to the contrary notwithstanding, it is desirable to test a tube with respect to emission or noise factors while the tube is in its normal operating position. Tube testers usually give a "yes" or "no" answer but do not ordinarily indicate at which point on the gradually-changing emission slope a particular tube lies.

Standby Practice

Tube life can be directly increased by shutting off equipment which is not in use. In a majority of audio plants it was pre-war practice to have all equipment energized throughout the operating day. This procedure is often justified by the requirement that equipment must be immediately available, either for normal operation or emergencies, and by the fact that most tubes require a warm-up period.

Tubes are now more difficult to obtain and some variations in practice are advisable. Much equipment is never required for immediate use and instances will be found where groups of equipment can be turned on or off as the operating day approaches and recedes from its climax. Further, in the case of auditions and rehearsals warm-up time is not too important.

Sometimes the equipment shut-off problem involves lack of manpower for proper attention. This can usually be taken care of by the installation of convenient switches or by sectionalizing power-input circuits and switches to handle selected groups of equipment. Time switches can often be used to

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advantage in local as well as outlying equipment.

It is hoped that the foregoing will provide food for thought in dealing with the small vacuum-tube procurement and life problem. While it is not advocated that audio operating personnel engage in extensive projects to attain unusual tube-use efficiency, it is at least desirable that specific cases of reduced tube life be investigated and attended to. In any case, the desire for tube economies should be joined with some healthy curiosity and an open mind concerning possible solutions, even if they do seem to require some trouble. In that manner the required results will be assured. And do not overlook the practical and educational value of keeping records.

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Design Chart

(*Continued from page* 144)

chart, it is necessary to change the decimal points of the L, C, and f scales according to Fig. 1. This change doesn't affect the upper section of the chart, because the reactance values remain unchanged. The range of all other scales may be shifted by similarly shifting decimal points.

The fixed capacity- kva- and maximum-voltage lines are drawn in Fig. 1. The available frequency range is shaded, as is the resulting reactance-spread of 32 to 105 ohms. The desired kva obviously may be obtained at 1800 to 2500 v, depending on the frequency used. Since the maximum permissible stress of 2500 v is within the shaded range, the implied 62 ohms and 2500 kc would be used, giving a current of 40 amperes.

Capacitor Application

Assume that a certain 0.1-μf 10-kv d-c blocking capacitor may have a 2 percent super-imposed alternating voltage of 200 v at 200 kc, and that it is desired to know at what alternating voltage the capacitor may be operated at other frequencies. Referring to Fig. 2, or the chart, the 0.1-μf lines cross at 8.0 ohms in the lower half; this 8-ohm reactance line followed up to the 200-v line gives 5 kva and 25 amperes. These last two values es-

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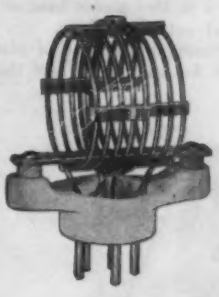

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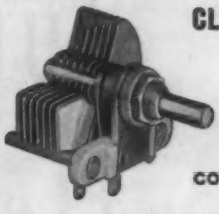
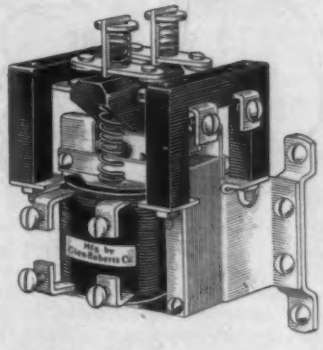


CONDENSERS



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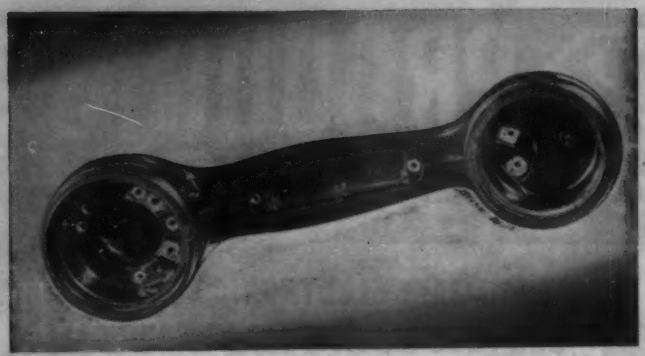

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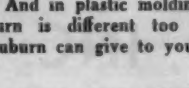

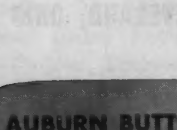

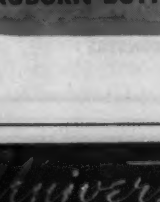

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tablish the thermal limits of the capacitor, neither of which are to be exceeded.

At some new frequency—say 500 kc, the intersection with 0.1 μf occurs at 3.15 ohms, which—at 25 amperes, gives 2 kva and 80 v a.c.

At 50 kc the capacitor's reactance is 31.5 ohms, resulting in a 20 kva burden at 25 amperes. So the 31.5-ohm line must not extend beyond its intersection with 5 kva, which corresponds to 13 amperes and 400 v a.c.

It is apparent, therefore, that the intersection of any reactance line with those of current and kva, shown heavy in Fig. 2, will determine the maximum permissible alternating voltage at the frequency desired, provided of course that the combined alternating and direct voltage do not exceed the rating for dielectric strength.

The same procedure could be followed in ascertaining permissible working conditions at various frequencies for power factor correction, or for tuning capacitors used with induction-heating coils or furnaces.

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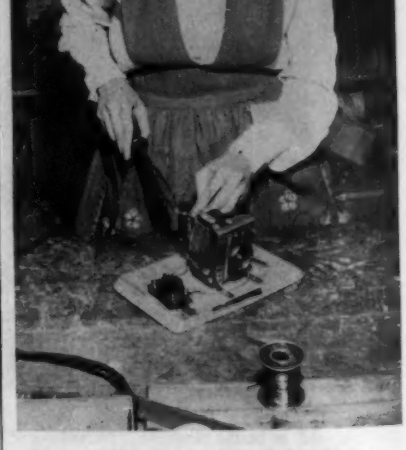
BLIND RADIO STUDENT



Mary Maderas, 19, solders leads of a one-tube receiver she is building in a beginner class at the New York Institute for the Education of the Blind

Backtalk

This department is operated as an open forum where our readers may discuss problems of the electronic industry or comment on articles which ELECTRONICS has published.

Why Industry Goes Slow on Electronics

I CAN GIVE YOU reasons given me by a large drink manufacturing plant. It is quite large and in most of its buildings it could use a large quantity of electronic gadgets in the mixing, weighing, packaging and conveying of the products before and after manufacture. There are, however, only one or two devices using electronics.

The main reason offered for this situation is the failure of all things electronic, tubes, condensers, etc. involving lots of time loss for trouble-shooting and repair.

Another reason is that even if they have all the electronic controls possible, they could not keep one or two men on the payroll for their maintenance alone as they would not be busy enough to warrant hiring and the equipment would be too complex for the usual run of plant electricians.

I have found that companies having electronic devices find it too expensive to get factory service for every breakdown, hence call the local radio service man who usually knows nothing about the equipment and depends upon the manufacturer's instructions books. These, from my experience, are about as clear as mud and tell all but what should be told for proper checking of the equipment. Usually they give circuits and components but neglect resistance and voltage charts. A checking procedure that could be followed with a good volt—ohmmeter, etc.

Several times I have worked on equipment and, because I placed the seat of trouble at sources requiring rebuilding the original setup used, (involving considerable work and

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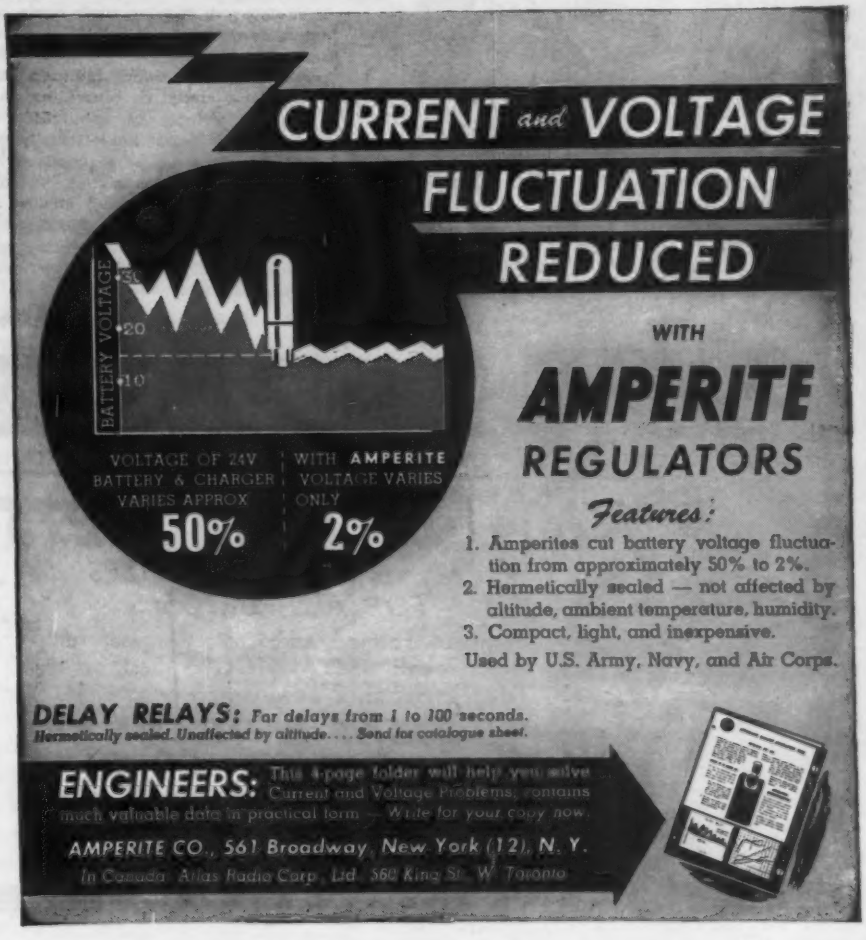
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WEIGHT:
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AMERICAN GAS ACCUMULATOR COMPANY

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STEEL PRODUCTS COMPANY
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42 YEARS EXPERIENCE

expense getting the defective unit out, repaired, and replaced), was told I didn't know anything about it. Hence when the factory representative confirmed the diagnosis, I received no credit and practically no compensation for my pains.

I know that if I were running a plant I would use as little electronic equipment as possible, as I have no faith in any electronic device. That's the way I make my living, —off equipment failures.

What are the manufacturers (not radio, sound and talking picture) doing to get the general run of radio service men qualified to service other electronic equipment. Nothing! Usually they will not answer question letters. These cut the profits from their service departments.

The electronic manufacturers should give some qualified service man in each community instructions and service data for their equipment sold in a given territory. Something of this nature would do a lot to promote sales by showing the buyer that he can call in a local man at a moment's notice and get qualified service.

W. C.,
New Orleans

• • •

Electronics in Canada

IN YOUR Cross Talk Editorial in the December 1943 issue of ELECTRONICS, I noticed your article entitled "Ignorance". This article struck a responsive chord so I thought a word on this subject regarding our solution of this problem may help, or at least give you some idea of

PLYTUBE is a light-weight plywood tubing in which the lay of the winding of the veneers is adjusted to fit specific needs. One method of winding is used if the tube must withstand radial crushing pressure or internal hydrostatic pressure. Other methods are used for torsion, columnar compression, flexural and tensile strengths. It has found a variety of wartime uses, from sectional for life-rafts oars to radio antenna masts.

WANTED:

Electronic or electro-mechanical products

(equipment, parts, or consumer items)

for the post-war era by modern, well-organized manufacturer of radio parts, who desires to add new products.

Apply to W-646 Electronics
330 West 42nd Street, New York 18, N. Y.

what we in Canada are doing.

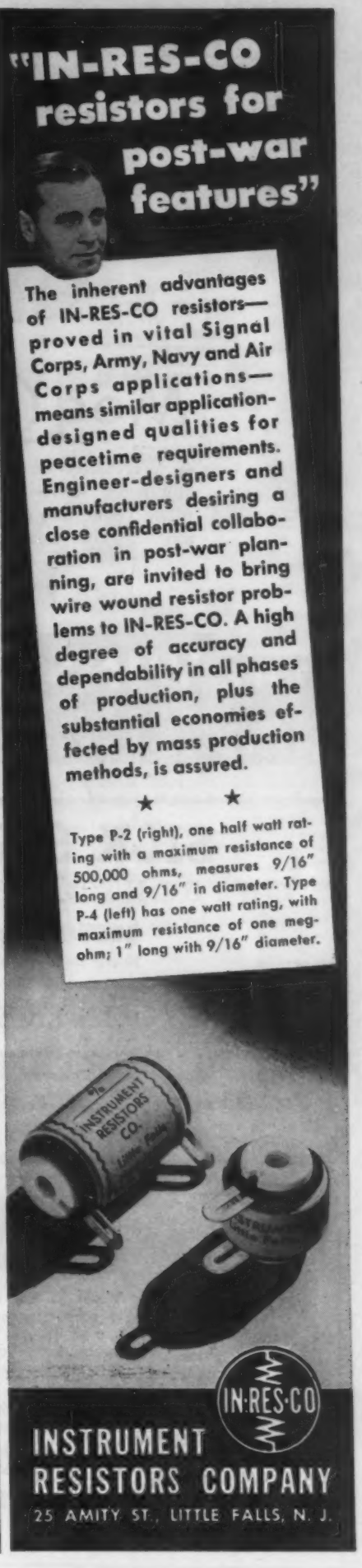
Sometime ago a group of electrical men—representing most of the industries in this district—gathered together to discuss the possibilities of electronics and how it may effect our future thinking. Some of us had operated as "hams", and I suppose what meager knowledge we possessed helped us to get started properly. The outcome of this meeting was the formation of a group of electronic-minded electrical engineers whose purpose is to discuss developments; solve any problems (if we can) arising from the use of electronics; arrange for speakers to discourse in their particular field, providing it deals with electronics, and in this connection only.

While we meet every month, the alternate monthly meetings are devoted to a purely technical discussion for the benefit of the 30 members of this organization. For the other meetings we arrange to invite executives and production men to sit in, while our speaker is requested to address us in elementary language so far as it is possible. This way we feel we can acquaint our guests with some of the underlying principles of electronics and its effect on their particular phase of industry.

We have elected a slate of officers comprising a chairman, three directors, and a secretary-treasurer. Each member of this organization has to be prepared at all times to discuss a phase of electronic control. In this way we feel that the members must study or else be caught some day with nothing to say. All discussions and speeches are recorded verbatim in shorthand, and transcribed copies are made available to members for the purpose of study and also to provide a ready means of reference.

We feel we are off to a good start and only time will tell whether our

IN 1943, production of radio equipment jumped more than 110 percent over 1942, while the 1943 total for all types of signal equipment rose 130 percent above the 1942 level. There was declining emphasis on ground radio equipment, and a big expansion in airborne signal equipment.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The inherent advantages of IN-RES-CO resistors—proved in vital Signal Corps, Army, Navy and Air Corps applications—means similar application-designed qualities for peacetime requirements. Engineer-designers and manufacturers desiring a close confidential collaboration in post-war planning, are invited to bring wire wound resistor problems to IN-RES-CO. A high degree of accuracy and dependability in all phases of production, plus the substantial economies effected by mass production methods, is assured.
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Type P-2 (right), one half watt rating with a maximum resistance of 500,000 ohms, measures 9/16" long and 9/16" in diameter. Type P-4 (left) has one watt rating, with maximum resistance of one megohm; 1" long with 9/16" diameter.
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To protect tubes and other plug-in components from loosening under vibration, get acquainted with
BIRTCHER LOCKING TYPE
TUBE CLAMPS
See page 364 this issue, and 'phone, wire, or write us.

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THE BIRTCHER CORPORATION
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of every type,—standard, and special design
Specialists in Equipment for the manufacture of Radio Tubes, Cathode Ray Tubes, Fluorescent Lamps, Incandescent Lamps, Neon Tubes, Photo Cells, X-ray Tubes and other glass or electronic products, on production or laboratory basis.
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Making a modest but effective contribution in Electronics' War accomplishments.
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Troubled executives find new *QUILTED* asbestos mitt *won't* shred, *won't* fray on tough jobs handling hot metals, molds, other hot materials. Quilted both sides, reversible to fit either hand; gives double duty, double wear. Just one of many interesting Safety Ideas invaluable to production-minded executives.
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Make it a HABIT . . . to check this page—EACH ISSUE
THIS CONTACTS SECTION supplements other advertising in this issue with these additional announcements of products and services essential to efficient and economical operation in the field of ELECTRONICS

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Consulting Engineers
Industrial Electronics & Communications
Earle Bldg., Washington 4, D. C.

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on Adequate
Priority

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★ WINSLOW-made megohmmeters, with true ohmmeter movements manufactured in our plant. For testing insulation resistance of cables, motors, generators, etc. Hand-driven generators —direct reading—compact—rugged.

Write for detailed specifications and prices

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SILK SCREENING
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METAL and PLASTICS

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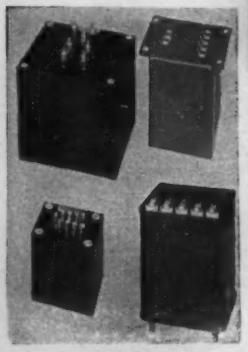
Inventors of New Inlay Process *See Page No. 368*



Planning *Post War* Products?

When you get the "green light" to convert to peacetime production, will you be among the fortunate who are all set to go, or will you have to start from scratch?

See DONGAN About Transformers!

If you are planning on new post-war products that will employ transformers, it is all the more important that you arrange in advance for your requirements.

Send your specifications for a quotation

DONGAN ELECTRIC MANUFACTURING CO.

"DONGAN" 2977 Franklin Detroit 7, Michigan

"The Dongan Line Since 1909"

efforts will bear fruit. In any case, we are getting acquainted with one another over the dinner table and hope, eventually, to dispel our ignorance regarding what "happens between cathode and anode across the evacuated space".

JOHN R. MARSH
Chairman,
Society of Electronic Engineers
St. Catherines, Ontario

• • •

VHF Relays

IN A RECENT SPEECH Mr. James D. Shouse, vice-president of WLW, stated that American broadcasters had better start planning new technical equipment to get programs to Europe after the war at least as well as the BBC does now. He further stated that our present short-wave stations do not have an adequate signal reaching the European soil and the many millions who represent a powerful potential post-war market for American products.

The ideal frequency for European coverage, due to the type of receivers in use there, would be in the region of our standard broadcast band. The problem resolves itself into one of getting the programs over there reliably with reasonable fidelity and not subject to the vagaries of short-wave transmission, if they are to have any value as a commercial medium.

A system of VHF relays across the Atlantic would seem to be a good solution to the problem. These could be mounted on towers of considerable height with a foundation moored to the ocean floor. They could be designed to be virtually automatic in operation with dual channel safety changeover systems. A site could be chosen for the installation of standard broadcast

MORE THAN 7,000 tubes operate continuously in the receiving sets at RCAC's Receiving Central at Riverhead, L. I. Heat from the tubes keeps the equipment dry and stable in operation and saves 2800 gallons of fuel oil per season since an air circulating system was installed.

New England Screw Co.

KEENE, NEW HAMPSHIRE

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YEARS OF
SPECIALIZED EXPERIENCE

MACHINE SCREWS — PLASTIC INSETS
SHEET METAL SCREWS — HOLDING PINS
MACHINE SCREW NUTS — SPECIAL RIVETS
ALL TYPES OF HEADS AND THREADS

word into a microphone. Therefore, this would indicate that the cause is either in the human throat structure, or in the microphone itself.

Voices rich in harmonics had the most noticeable un-balance. Talking in my natural voice, the peak difference was apparent, but raising my tone to a high falsetto resulted in a condition wherein the peaks were almost perfectly balanced!

I noticed another pecularity: The 250-K speech-input stage of p/p 1620's has quite a large amount of inverse feed-back from the 828 modulators. With some voices, the right-hand modulator plate meter will kick slightly earlier than the other, and the two meters will be slightly out of step with each other. With music, they behave more like Class B plate meters. With the inverse feed-back circuit opened, the meters kicked in step on both speech and music, but of course the stage became unstable, due to the sensitivity of the 1620's and 828's.

LEE CLOUGH
Chief Engineer
KLUF

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SEARCHLIGHT SECTION

POSITIONS VACANT

SALES ENGINEER WANTED, Chicago territory, for established manufacturer of metal fasteners widely used by industry on war and peacetime products. Prefer resident Chicago area, age 30-35 with engineering training. Give full details, education, experience, draft status, age, salary expected and recent photograph. Require statement of availability if engaged in war work or essential activity. P-615, Electronics, 330 W. 42nd St., New York 18, N. Y.

ELECTRONIC ENGINEERS wanted for new department in old company with outstanding reputation. Development or production abilities sought in field of electronic instruments and control devices. Advancement should be rapid. Write stating experience, education, salary expected, draft status and availability if now engaged in essential war work. P-637, Electronics, 330 W. 42nd St., New York 18, N. Y.

ELECTRONIC SALES ENGINEER—As field contact man with established parts manufacturer. Must be well acquainted with engineers in tube, set and components plants and active in radio engineering societies. Attractive proposition. State availability, education, experience and qualifications. Members of our organization know of this opening. Reply to P-638, Electronics, 330 W. 42nd St., New York 18, N. Y.

SALES PROMOTION MANAGER—Established parts manufacturer in radio and electronics field wants thoroughly experienced man, with executive ability, familiar with buying policies of these industries. In reply give availability, education, experience and qualifications. Draft status. Reply to P-639, Electronics, 330 W. 42nd St., New York 18 N. Y.

(Additional Position Vacant Ads on pages 404 and 405)

EMPLOYMENT AGENCY

ENGINEERS — Mechanical—Industrial—Electrical—Chemical—Civil—Architectural, etc. Our specialized service to Technical and Scientific men only, for over 50 years, continuously at the same address, enables us to offer a fine selection of positions for high grade Manufacturing Executives, Production Managers, Metallurgists and Technical men of all types. The Engineering Agency, Inc., 53 W. Jackson Blvd., Chicago 4, Ill.

POSITIONS WANTED

CONSULTING ENGINEER (electrical & mechanical) complete laboratory facilities. 15 years practical experience electronics & relay controlled systems, instruments, motion picture sound recording installations, broadcasting equipment. Authority on ground systems. Art Davis, 1508 W. Verdugo, Burbank, Calif.

ENGINEER experienced in audio design, midget tube production, wants post-war contacts in Chicago area. PW-647, Electronics, 330 W. 42nd St., New York 18, N. Y.

ENGINEER-PHYSICIST—Radio and Electronics desires permanent position in research and development in electronics. One year experience research high voltage cables, four years development and design of radio and electronic test equipment. PW-648, Electronics, 330 W. 42nd St., New York 18, N. Y.

WANTED

WANTED: 1 Farnsworth 6 Stage or 11 Stage Infra Red Sensitive Photo Multiplier tube for important war research work. W-640, Electronics, 330 W. 42nd St., New York 18, N. Y.

ATTENTION! Quality Mfg'rs.

Whose products are used by Industrials, Electronics Mfgrs. and Jobbing trade—If you are seeking exceptional sales representation, engineered on solid foundation, for post-war opportunity—contact

RA-650 Electronics
330 West 42nd St., New York 18, N. Y.

NEW "SEARCHLIGHT" ADVERTISEMENTS
received by April 14th appear in the May issue, subject to space limitations.

Address copy to the Departmental Staff
ELECTRONICS
330 West 42nd St., New York 18, N. Y.

Attention Manufacturers

Do your planting and weeding early
Be ready to harvest when Victory comes.

Plan your distribution now, be ready for your post war production output.

Of course you must continue on war production work day and night to speed that final day. Therefore, post war business is the furthest from your mind now. But to plan then, in a short space of time, would be an expensive problem.

As a manufacturers representative for over 15 years in the New England and New York territory, constantly calling and talking to various distributors of radio and appliance lines, I find these progressive distributors are anxious to plan now as to "Whose" lines they will carry. Together, we are planning. Why not You be the "Whose" line the distributor will sell.

With my past record of volume business and established clientele, I could help you in establishing your product with the cream of the crop in this territory.

Your inquiry will be held strictly confidential.

RA-649 Electronics
330 W. 42nd St., New York 18, N. Y.

New York City — Philadelphia and New Jersey
RADIO - ELECTRONIC SALES REPRESENTATIVE
IS INTERESTED IN SECURING LINES OF ESTABLISHED MERIT for
JOBBER FIELD

Highly successful sales representative of national repute with outstanding background in radio parts field since early 1920's can add one or two lines for distribution and promotion by select jobber following in metropolitan New York—Philadelphia—New Jersey areas. Inquiries and correspondence treated in utmost confidence. Write

RA-645, Electronics
330 W. 42nd St., New York 18, N. Y.

Additional Employment Advertising on pages 296, 308, 316 & 356

"HARD-TO-SOLDER" PLACES ARE EASY

to reach with the efficient KELNOR iron which quickly, accurately solders without danger of burning insulation on adjacent wires . . . and in places most difficult to get at with conventional type irons.

KELNOR *electric* SOLDERING IRONS

REG. U.S. PAT. OFF. (PATENTS APPLIED FOR)

Some KELNOR Features:

1. KELNOR Weighs Only 8 Ounces
2. Special KELNOR Extendable Tip
3. Balanced KELNOR Angle-Head
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A precision-built tool of highest quality. KELNOR Soldering Irons are specially designed for making quick, solid, sure connections in such fields as Radio, Aircraft, Telephone, Telegraph, Shipbuilding, etc.

APPROVED BY UNDERWRITERS LABORATORIES, Inc.

Order through your JOBBER — or, for more facts, and prices, write National Sales Agent, Wm. Weston and Co., 550 Page St., San Francisco 17, Calif., or

KELNOR MANUFACTURING CO. GENERAL OFFICES: CENTRAL TOWER, SAN FRANCISCO 3

UNITED DYNAMOTORS

Manufactured under government specifications with government inspection at our plant.

PROMPT DELIVERIES

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Zophar offers prompt service on Insulating Compounds for a wide variety of electrical applications, including:

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Special compounds made to your order.

ZOPHAR MILLS INC.

130-26th St. Brooklyn, N. Y.

FOUNDED 1846

transmitters on the other side, and we would have a reliable path for American broadcasting to our European listeners.

At first glance the idea may seem fantastic, but relays of this type are now in operation in this country and they will come into common use with the advent of post-war television networks. The cost would not be out of proportion to the advantages to be gained in goodwill and the commercial opportunities offered by European markets.

BERNARD SEAMON
Wiscasset, Maine

• • •

Polarized Speech

HAVING BEEN up against a peculiar problem for a few years, and having been unable to find a comprehensive discussion of the matter in any of the various manuals and texts, I am writing to ask whether you can steer me to a source of information, and also to suggest a topic of interest for a possible future article in ELECTRONICS.

This problem is one of unequal positive and negative peaks of modulation of the broadcast carrier wave. Before installing a limiter built along the lines of the one designed by Mr. Herrick, (Dec. 1943 ELECTRONICS), this differentiation was only slightly noticeable, but, when volume compression was used, the effect became quite pronounced!

Becoming interested in this, I substituted a dummy antenna on our RCA 250-K, and with both microphone, turntable, and b-f oscillator, began experimenting. I found that with a pure wave, the peaks were equal, also with musical transcriptions; but with speech the results were quite different! Using the voices of our various announcers, I soon found that the harsher male voice had a pronounced difference in positive and negative peaks, but that the average female voice had an effect of producing a condition of equal, or nearly so, peaks. The polarity of the peak condition could be reversed by reversing either the microphone connections, or the input connections to the limiter. I also found that the transcribed voice had the same effect as the spoken

(Continued from page 403)

WANTED

ELECTRONIC ENGINEERS

A well established company of excellent reputation located in the east, offers permanent position to a few engineers who have educational training and background in Electronic engineering or Physics. Unusual opportunities offered men who possess originality and initiative in connection with research and developments relating to television, radio, sound reproduction and other applications. Write full particulars relative to education and experience.

P. 635, Electronics, 330 West 42nd St., New York 18, N. Y.

RADIO-ELECTRONIC

ENGINEERS
TESTERS
TECHNICIANS

EXCELLENT OPPORTUNITIES IN A MAJOR POST WAR FIELD

Openings available at our Research Laboratories and Electronic manufacturing unit. Leaders in the design and development of vital electronic equipment for the armed forces.

Essential workers need release statement.

Write, stating experience, education, draft status, salary requirements or apply to

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GYROSCOPE CO., INC.
Research Labs. & Electronic Plant
Stewart Ave. & Clinton Rd.
Garden City, New York

Permanent Positions

Available with national manufacturer in essential X-Ray industry. Experienced Field Service and Sales Engineers will be placed in branch offices immediately. Factory training courses available for man with technical background. Excellent opportunity for Electrical Engineers. Work is interesting and under pleasant conditions. Ample opportunities for advancement.

Write the Supervisor, Technical Employment

Union Bank Building
Pittsburgh 22, Pennsylvania

WESTINGHOUSE ELECTRIC & MANUFACTURING CO.

PERMANENT POSITION
for

Electroacoustic or Electromechanical Engineer

Must have substantial experience and demonstrated initiative in design and measurement of practical electroacoustic or electromechanical transducers. To illustrate the requirements, he must be capable of taking full responsibility for determining the equivalent circuit constants of piezo-electric crystal plates and assemblies used as transducers, including the development of necessary measuring apparatus and techniques. The position offers excellent opportunity to contribute to the War effort, followed by a continuing program of post war development.

Write to: A. L. WILLIAMS, *President*

THE BRUSH DEVELOPMENT CO.
3311 Perkins Ave., Cleveland 14, Ohio

WANTED

Electrical Engineers

Development and design work in transformer applications for radar, lighting, power, etc. Also junior engineers for drafting and layout. 100% war work. Excellent post war potential in research laboratory or sales engineering department. If you are not utilizing maximum skill at present position apply by letter at once.

SOLA ELECTRIC COMPANY
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MOTOR DESIGN ENGINEER

Must be thoroughly experienced in design and production of fractional horse-power motors and generators. Only top-notch man considered. All replies confidential and must be complete. Excellent opportunities—location southern New England. Statement of availability required.

P-641, Electronics
330 W. 42nd St., New York 18, N. Y.

WANTED

ENGINEERS—DESIGNERS

ELECTRICAL, MECHANICAL
RADIO, ACOUSTICAL

For Research and Development Laboratory of established company engaged in war work. Activity includes electronic control equipment, continuous recorders, special radio devices, and aircraft accessories.

Excellent post-war opportunities. Laboratory located in central Manhattan. All replies strictly confidential. Write full details.

P-651, Electronics
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ENGINEER

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ELECTRONIC or ELECTRICAL
Experience for Research
and Development in our

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Post War Future
Good Salary for Right Applicant

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ELECTROLYTIC CAPACITOR CHIEF ENGINEER

Capable of designing and supervising installation of equipment. To take complete charge of laboratory and supervise production quality control. Must have previous experience with etching and formation processes. Write stating experience, education, draft status, present and previous earnings and salary requirements. All replies will be held in strictest confidence. Excellent post war possibilities involving inclusion in owner-management group of young, aggressive capacitor manufacturer. Address,

P-644, Electronics
520 N. Michigan Ave., Chicago 11, Ill.

WANTED

DRAFTSMAN

Experienced man for real critical war work. We also have fine opportunity from postwar standpoint. If you have had plant layout, piping, machine design, architectural or any mechanical drawing background, write us at once. State experience and salary desired.

P-643, Electronics
520 North Michigan Ave., Chicago 11, Ill.

WANTED

ENGINEERS

Electronic **Mechanical**

This company is engaged in the design and manufacturing of radar testing equipment, audio amplifiers, and video equipment. Also, manufacturing small mechanical parts.

The engineers we need must have experience in the electronic industry. These positions offer immediate and postwar opportunities. Write and include full details as to experience and salary desired.

THE MODERN ELECTRONICS CO.
409 North Broad St., Elizabeth, N.J.

WANTED

ENGINEER - Communication Equipment

To design electronic devices, transformers, filters, etc.—mostly Audio frequency. Working knowledge of trigonometry and LC circuits necessary. Also some experience on communications equipment or mechanical manufacturing. Salary open. Draft exempt or deferable by reason of education or experience. Excellent post-war prospects. USES referral card will be required.

AUDIO DEVELOPMENT CO.,
2833—13th Ave. So. Minneapolis, Minn.

POSITIONS VACANT

The Engineering Experiment Station of the University of Florida is interested in obtaining radio and electronic engineers and radio-physicists for research on contracts with government agencies. While this work is of a war nature, some of the positions will be permanent, depending largely on the ability of the man.

THE ENGINEERING EXPERIMENT STATION
University of Florida Gainesville, Fla.

(Additional Position Vacant Ads on Page 405)